Folks,

TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE), OP 1586, 27 February 1947 was created just after WW II. It describes the peak of WW II US destroyer torpedo fire control technology.

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Search Torpedo Fire Control Equipment (Destroyer Type)

RESTRICTED OP 1586

TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE)

TORPEDO DIRECTOR MARK 27
TELESCOPE MARK 50
FIRING KEY MARK 19
TORPEDO COURSE INDICATOR MARK 1

A BUREAU OF ORDNANCE PUBLICATION 27 FEBRUARY 1947

RESTRICTED **OP 1586**

TORPEDO CONTROL EQIUPMENT (DESTROYER TYPE)

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27 FEBRUARY 1947

This publication is RESTRICTED and shall be safeguarded in accordance with the security provisions of U. S. Navy Regulations 1920, Article 76.

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON 25, D. C.

27 February 1947

RESTRICTED

ORDNANCE PAMPHLET 1586

TORPEDO DIRECTOR MARK 27 MODS 1 TO 9
WITH TELESCOPE MARK 50 MODS 0 AND 1,
FIRING KEY MARK 19 MODS 0 AND 1,
AND THE TORPEDO INDICATOR MARK 1 MODS 0 TO 4

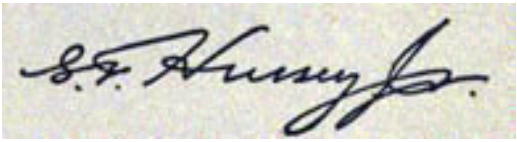
1. This Ordnance Pamphlet contains information on the description, operation, installation, maintenance, and overhaul of destroyer type fire control equipment. The equipment includes the Torpedo Director Mark 27 Mods 1 to 9 with Telescope Mark 50 Mods 0 and 1 and Firing Key Mark 19 Mods 0 and 1 installed and the Torpedo Indicator Mark 1 Mods 0 to 4.

2. The description of the torpedo director includes the alterations which were authorized by the following NAVORD ORDALTS:

ORDALT 1255-Instructions for installing centering device for sight angle motor follow-up
ORDALT 1787-Installation of red illumination for dials
ORDALT 2107-Installation of relative target bearing receiver

3. This publication supersedes Ordnance Pamphlet 585 (Second Revision), which should be destroyed

4. Ordnance Pamphlet 1586 is RESTRICTED and shall be safeguarded ordnance with the security provisions of U. S. Navy Regulations, 1920, Article 76.



G. F. HUSSEY, JR.
Vice Admiral, U. S. Navy
Chief of Bureau of Ordnance

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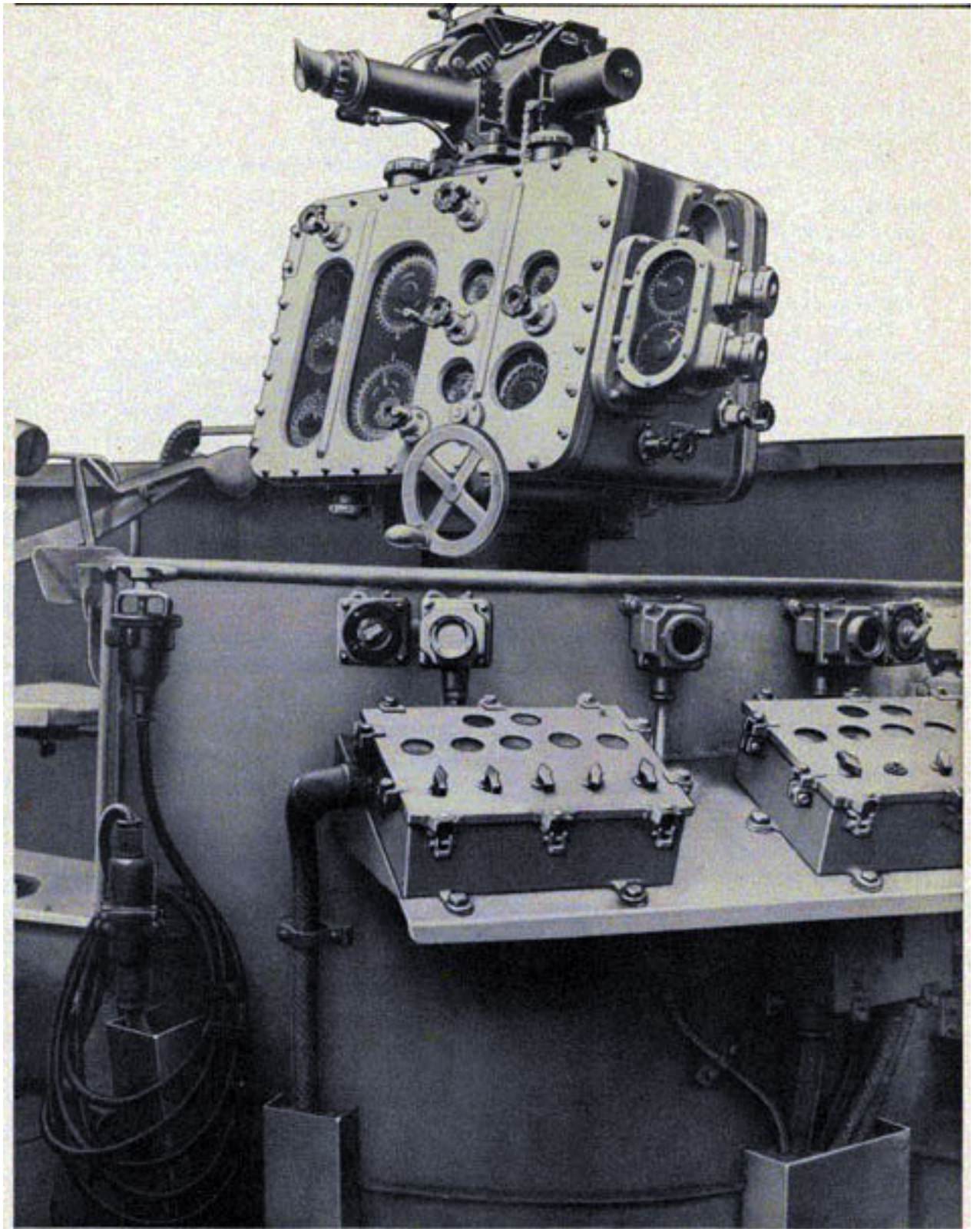


Figure 1-Torpedo Director Mk 27 Mods 1 to 9 is a torpedo fire control instrument. This view shows the director installed on the bridge of a modern destroyer.

Chapter I

TERMINOLOGY

This section defines the basic torpedo fire control terms used in this manual. A thorough understanding of these terms at the start will help clarify the principles and operation of the torpedo director.

Firing Point: This is the point where the torpedo begins its run; broadly, the position of own ship when the torpedo is fired.

Line of Sight: The straight line from the axis of rotation of the torpedo director to the point of aim on the target.

Point of Aim: The desired point on the target to be hit with the torpedo.

Torpedo Track: The path along which the torpedo proceeds through the water.

Usually, when a torpedo is fired, it travels in a straight line for a certain distance called the reach. At the end of this period of straight line travel, it may be caused to start on a circular course. The arc of the circular path is determined by setting the gyro in the torpedo. At the end of the circular path, the torpedo proceeds to the target in a straight line. This final straight line of the torpedo is called **final track** of the torpedo.

The various torpedo fire control symbols and terms, defined below, are illustrated in figure 2.

Symbol	Definition
B	**True Target Bearing**: The angle between the north-south line and the line of sight to thetarget, measured clockwise from the north (measured from 0 degrees to 360 degrees).
Bt	**Target Angle**: The angle between the fore and after axis of the target and the line of sight to the target, measured clockwise from the target's bow (measured from 0 degrees to 360 degrees).
Bs	**Relative Target Bearing**: The angle between the fore and after axis of own ship and the line of sight to the target, measured clockwise from the own ship's bow (measured from 0 degrees to 360 degrees).
Bto	**Torpedo Course**: In this manual reference is made to **torpedo course**. This term should be called **Relative Torpedo Course** because it is torpedo course angle measured relative to own ship. TorpedoCourse (relative) is the angle between fore and after axis of own ship and the **final track** of the actual torpedo, measured clockwise from the ship's bow (measured froth 0 degrees to 360 degrees). Torpedo Course Order is the value of torpedo course computed by the director.
Btr	**Track Angle**: The angle between the **final track** of the torpedo and the fore and after axis of the target measured clockwise from the bow of the target.
Btu	**Basic Tube Train**: The computed angle between the fore and after axis of own ship and the axis of the torpedo tube mount measured clockwise from the ship's bow (measured from 0 degrees to 360 degrees). Basic tube train does not include tube offset.

Bgy **Gyro Angle**: The angle between the axis of the torpedo tube and the final track of the actual torpedo, measured clockwise from the torpedo tube (measured from 0 degrees to 360 degrees). Gyro Angle Order is the value of gyro angle which is ordered to be set into the torpedo. In the torpedo fire control system described in this manual, gyro angle order is transmitted electrically at two-speed from the torpedo director to the torpedo course indicators at the torpedo tube mounts.

B'tu **Actual Tube Train**: The angle between the fore and after axis of own ship and the axis of the torpedo tube mount, corrected for tube offset, measured clockwise from the ship's bow (measured from 0 degrees to 360 degrees). In this manual, actual tube train does include tube offset and is equal to the algebraic sum of torpedo course (corrected for tube offset) and gyro angle. Figure 2 illustrates the case where actual tube train is equal to torpedo course minus gyro angle.

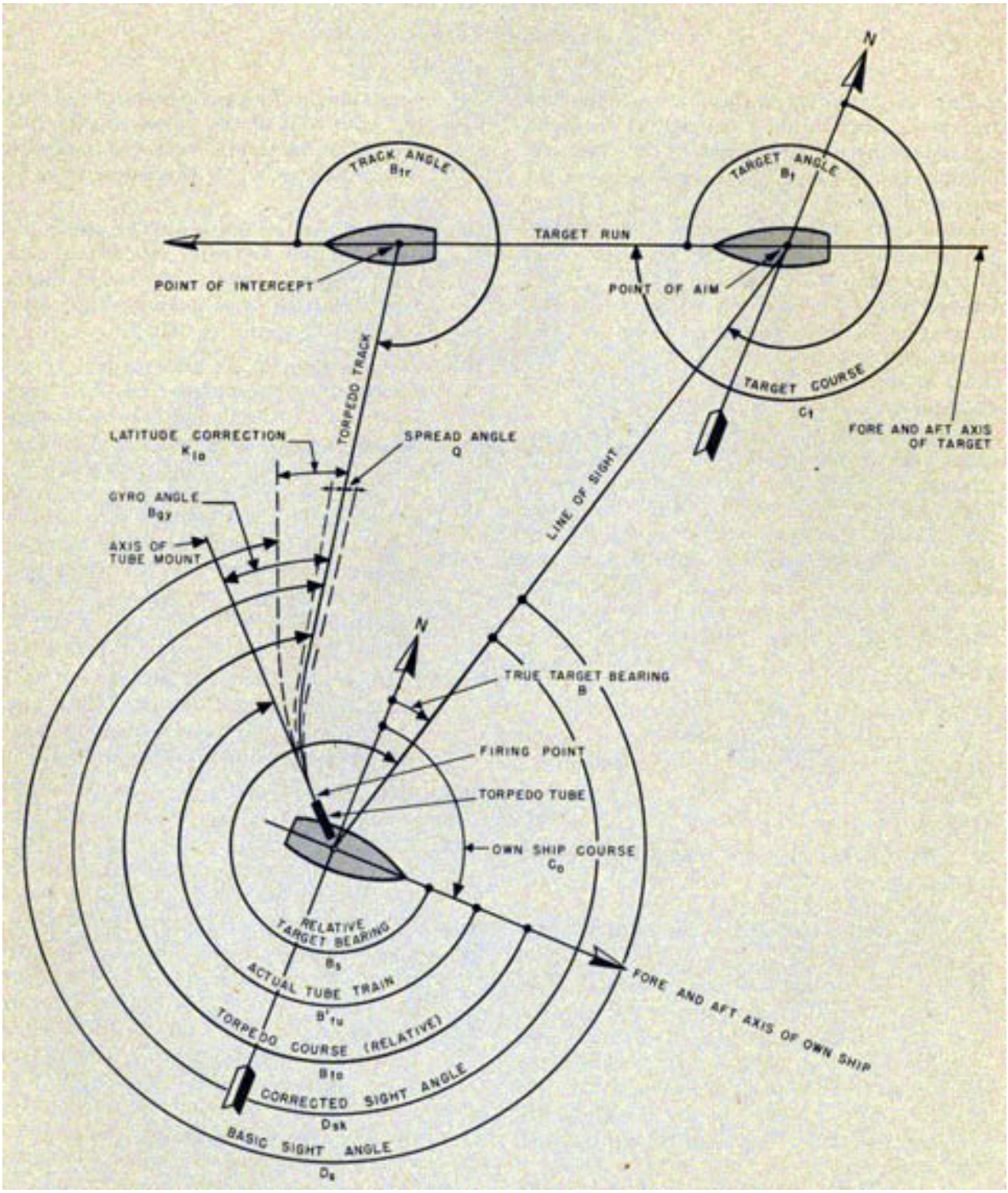


Figure 2-Graphic explanation of terminology.

2

TERMINOLOGY

Thus, actual tube train is the angle that the torpedo tubes make with the fore and After axis of own ship when torpedo course and gyro angle dials of the torpedo course indicator are matched. For a complete description of how actual tube train is produced, see page 11.

Co **Own Ship Course**: The angle between the north-south line and the fore and after axis of own ship, measured clockwise from the north to the bow of own ship (measured from 0 degrees to 360 degrees).

Ct **Target Course**: The angle between the north-south line and the fore and after axis of the target, measured clockwise from north to the bow of the target (measured from 0 degrees to 360 degrees).

Ds **Basic Sight Angle**: The computed angle from the line of sight to the **final track** of the torpedo measured clockwise.

Dsk **Corrected Sight Angle**: This is basic sight angle with latitude correction and intercept offset correction applied.

H **Target Run**: Distance run by target during the time of torpedo run.

Kla **Latitude Correction**: The correction required to compensate for the error due to proving (balancing) a torpedo gyro in one latitude and firing it in another. In other words, this correction is a change in sight angle to compensate for the inherent tendency of the torpedo to creep to the right in northern latitudes and to the left in southern latitudes, due to the earth's rotation. This quantity depends upon latitude and duration of the torpedo run.

Osi **Intercept Offset**: This is an arbitrary change in sight angle, right or left, to produce an offset angle, thus changing the point of intercept.

symmetrically about the basic (computed) torpedo course to obtain a spread between the mounts. In the torpedo director, **tube offset** is the angle between basic torpedo course and actual torpedo course.

Q **Spread Angle**: The angular difference between the **final track** of two adjacent torpedoes fired from the same tube mount exclusive of any change in **basic gyro angle** of the torpedoes.

So **Own Ship Speed**: Speed of own ship in knots.

St **Target Speed**: Speed of target in knots.

Sto **Torpedo Speed**: The average speed, in knots, of the actual torpedo from the muzzle of the tube to the point of intercept.

Xt **Target Deflection**: This is the component of target speed, perpendicular to the line of sight. In the torpedo director, this term is computed according to the equation,

Xt = St Sin Bt. **Target deflection** equals **target speed** times the sine of **target angle**.

Xto **Torpedo Deflection**: This is the component of torpedo speed, perpendicular to the line of sight. In the torpedo director, this term is computed according to the equation,

Xto = Sto Sin Ds. **Torpedo deflection** equals **torpedo speed** times the sine of **basic sight angle**.

Speed Ratio: The term speed, such as **one-speed** or **36-speed**, is used to indicate the ratio between a dial or shaft and the basic quantity with which it is associated. It has no relation to the sense of velocity. A clock, for example, measures the rotation of the earth. The small hand makes two revolutions per day, and thus operates at two-speed, while the big hand makes 24 revolutions to one revolution of the earth, operating at 24-speed. Thus, if a torpedo course dial or shaft turns at **one-speed**, it makes one complete revolution for each 360 degrees of torpedo course. If the dial or shaft operates at **36-speed**, it makes 36

Otu Tube Offset: The angle between the tube mount axis and the **basic tube train** measured right or left from the **basic tube train**.

In other words, tube offset is the angle by which torpedo course orders, transmitted from the director to the two torpedo tube mounts, are diverged

revolutions for each revolution of the **one-speed** dial or 360 degrees. Therefore, one revolution of the **36-speed**, dial or shaft represents 10 degrees.

In this manual the term **speed** will also be used in relation to the sense of velocity. Thus, in the term **target speed** or **torpedo speed**, speed means the velocity of the target or the torpedo and is usually expressed in knots.

COMPUTING LATITUDE CORRECTION

Latitude correction, Kla, is calculated and introduced, as a hand input, in the Torpedo Director Mk 27 Mods 1 to 9.

Several U. S. Navy publications develop the theory which underlies gyroscopic creep and latitude correction. One particular publication is OP 627 (A), "U. S. Navy Torpedo Gyroscopes, Non-Tumble Type". For the present purpose, it is sufficient to state that when the latitude in which torpedoes are fired differs from that for which the gyro balance nuts are set, a latitude correction to sight angle should be applied.

Either formula (1) or formula (2) given below should be used, as appropriate, to calculate the latitude correction

Kla = (0.0037 X R X (Sin L2-Sin L1)) / Sto **(1)**

L2 = firing latitude
L1 = balance latitude
Sto = torpedo speed in knots

Note: When L2 and L1 are on the same side of the equator, formula (1) applies; when L2 and L1 are on opposite sides of the equator, formula (2) applies.

The latitude correction, Kla is read on the outer dial of the intercept offset dial group against a fixed index and is introduced into the director in two steps

(1) By turning the latitude correction hand knob adjacent to dial group; each click of the hand knob represents one-sixth degree (ten minutes) correction. If L2 is north of L1, set the computed correction in the direction of the "N" as marked on the dial. This is equivalent to indexing the tube to the left and corrected sight angle will read less than basic sight angle. If L2 is south of L1, set the correction in the direction of "S" on the dial. This is equivalent to indexing the tube to the right and corrected sight angle will read more than basic sight angle.

(2) By turning the intercept offset hand crank. Rotation of this crank positions the inner dial of the intercept offset dial group. Since the intercept offset index on the ring dial is moved in setting latitude correction, it is **always** necessary to set intercept

or

Kla = (0.0037 X R X (Sin L2+Sin L1)) / Sto **(2)**

where Kla = latitude correction in **degrees**
R = =torpedo run in yards

offset after latitude correction is set. **If no offset is used, reset the inner dial to zero.**

Chapter 2

INTRODUCTION

This manual describes the operation, installation, repair, and maintenance of the Torpedo Director Mk 27 Mods 1 to 9, the Torpedo Course Indicator Mk 1 Mods 0 to 4, the Telescope Mk 50 Mods 0 and 1, and the Firing Key Mk 19 Mods 0 and 1. The construction and description of the Torpedo Director Mk 27 Mods 4 and 5 are covered in detail, but only the differences of the other mods from the Mods 4 and 5 are given.

The torpedo fire control problem and how the torpedo director solves this problem to supply torpedo course and gyro angle is also described. A typical torpedo fire control system installed on a modern destroyer is explained in this manual to show the application of the director and related torpedo fire control mechanisms. See figure 3.

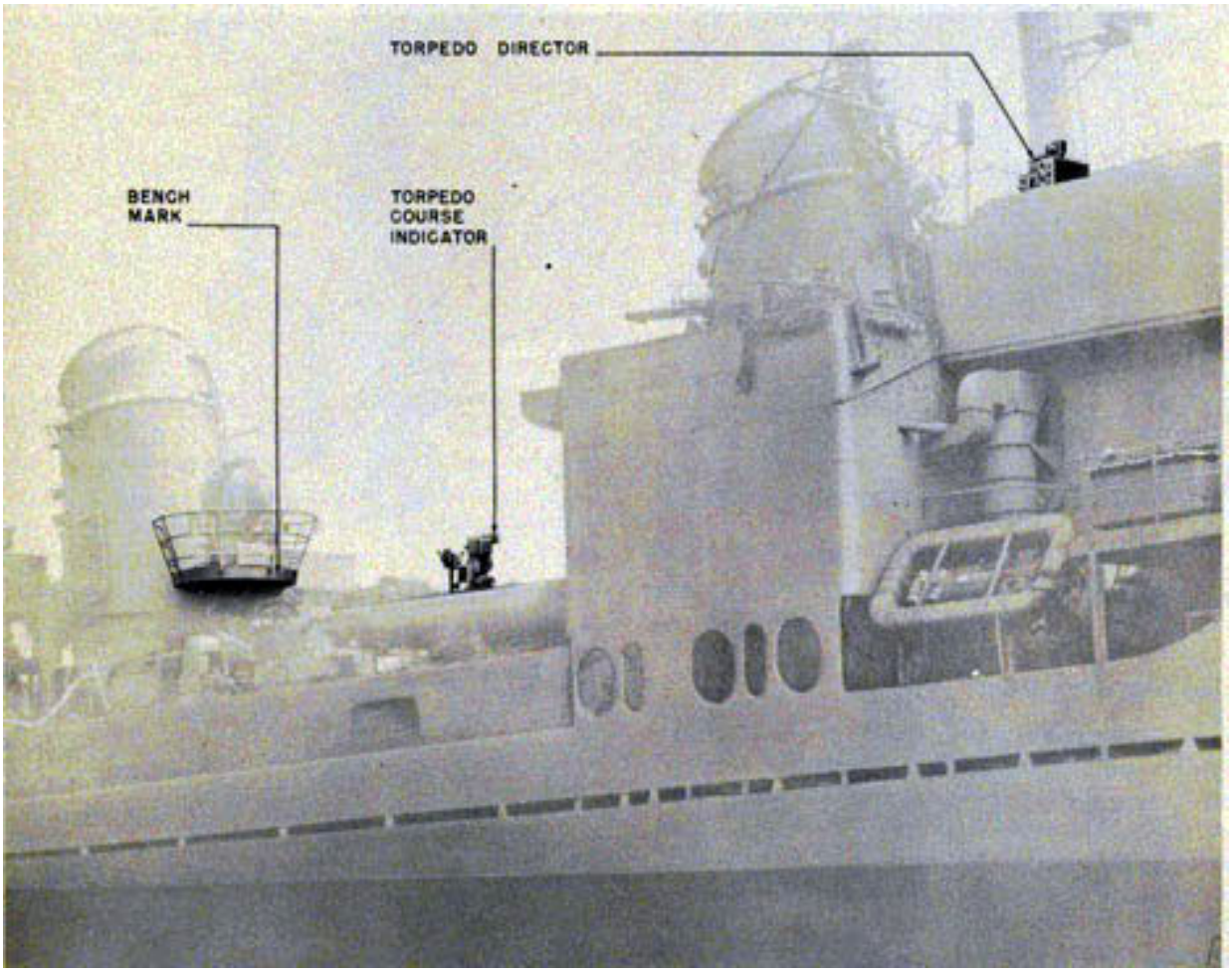


Figure 3-View of modern destroyer showing location of torpedo director, torpedo course indicator and bench mark.

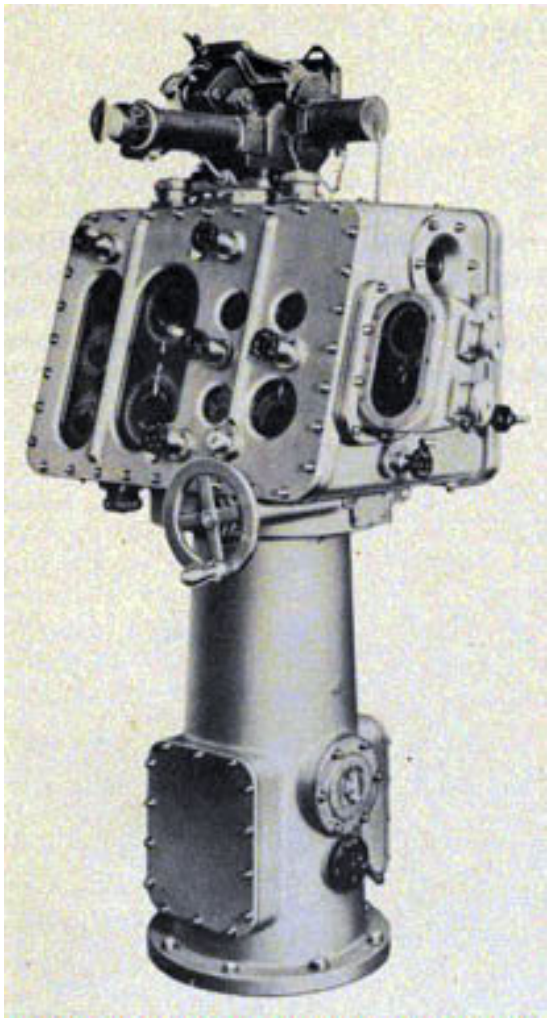


Figure 4-Front right view of Torpedo Director Mk 27 Mod 5.

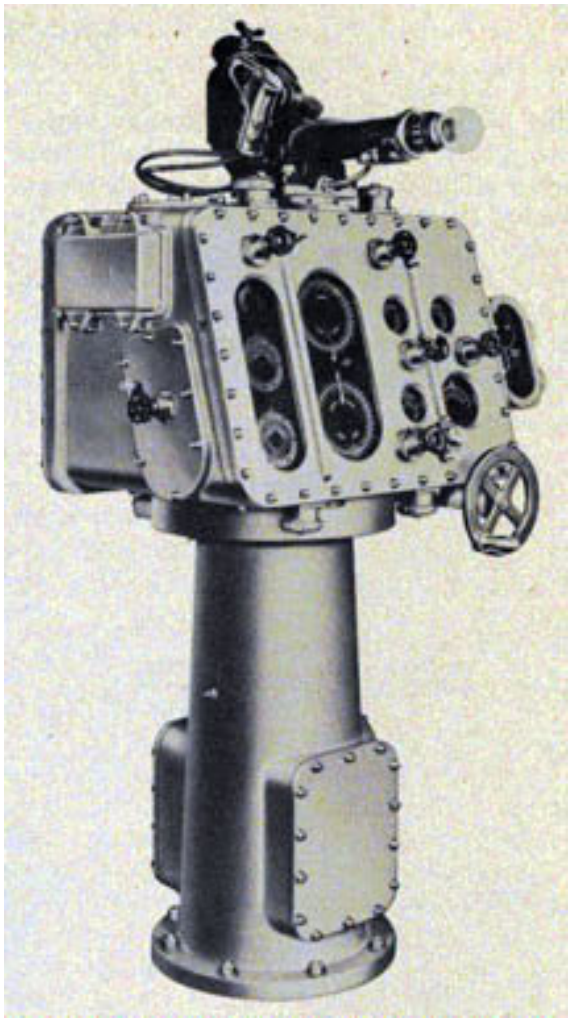


Figure 5-Front left view of Torpedo Director Mk 27 Mod 5.

What the Instruments Are

The torpedo director, see figure 4, is a fire control instrument which computes torpedo course relative) and transmits electrical torpedo course orders and gyro angle orders to the torpedo course indicators at the torpedo tube mounts. A firing key at the director when closed completes the firing circuit which launches the torpedo on its run to the target.

Where the Instruments Are Used.

The torpedo director and the torpedo course indicators are used in the torpedo fire-control system of modern destroyers. On destroyers having only one director, the director is mounted on the centerline of the signal bridge forward of the Gun Director Mk 37. When two torpedo directors are used, they are mounted in the wings of the signal bridge, one on the port and one on the starboard side. A torpedo course indicator is mounted on each of the torpedo tube mounts. See figure 3.

What the Instruments Do

The Torpedo Director Mk 27 produces, by electrical and mechanical means, torpedo

course and transmits torpedo course orders and gyro angle orders electrically to the torpedo course indicators. See figure 11. At the torpedo tube mount, the torpedo tubes are trained until the torpedo course and gyro angle dials of the indicators are matched. When these dials are matched, the tubes are trained correctly and **actual tube train** can be read directly from the tube train dial of the torpedo course indicator.

In actual operation, the torpedo director mechanically computes basic sight angle from the torpedo-speed triangle, corrects it for torpedo creep (latitude correction) and then combines the corrected sight angle with relative target bearing to produce basic torpedo course. The basic sight angle can be modified at the director to change the point of intercept without changing the problem set-up. The basic torpedo course can also be modified at the director for tube offset to produce torpedo course.

The tube offset provides a spread angle between the **two torpedo tube mounts** on the ship and should not be confused with the spread gyro angle set on the torpedoes of a given tube mount.

Synchro generators in the torpedo director continuously transmit (electrically) torpedo course at one-and 36-speed and gyro angle at two-speed to the torpedo course indicators at the torpedo tube mounts. Dials at the torpedo director show the values of all the quantities entering in the torpedo fire control problem and the values of torpedo course and gyro angle transmitted to the torpedo course indicators.

The torpedo course and gyro angle signals are received by synchro motors in the torpedo course

HOW THE DIRECTOR SOLVES THE TORPEDO FIRE TRIANGLE

Basically, the job of the director is to solve or produce the required relative torpedo course for firing torpedoes to hit the target. As shown in figure 146, torpedo course (relative) depends upon two quantities: (1) relative target bearing and (2) basic sight angle corrected for

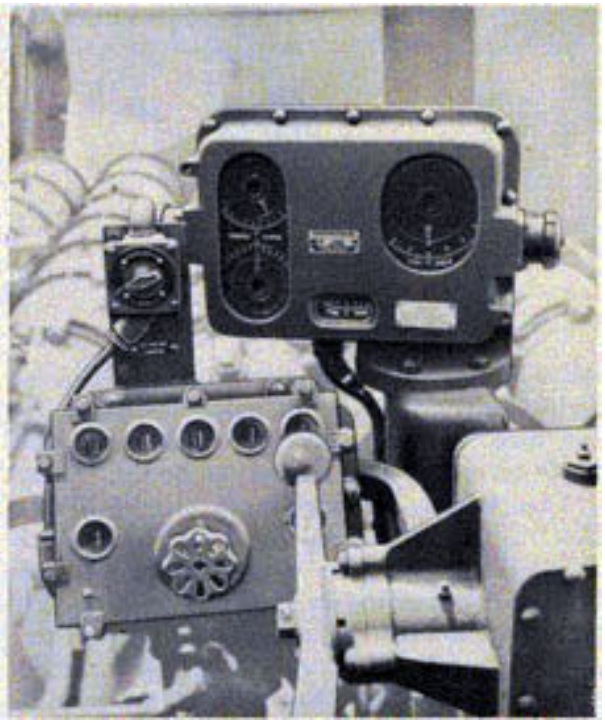
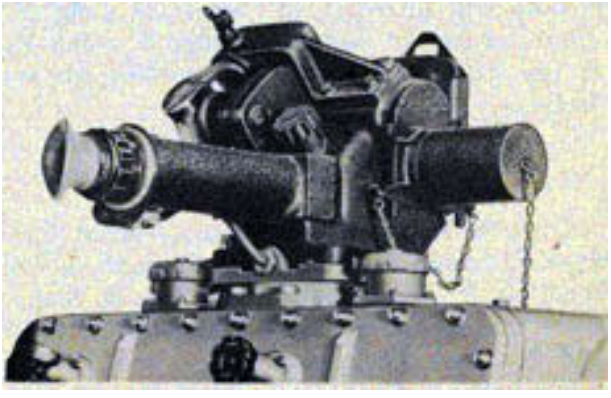


Figure 6-Torpedo Course Indicator Mk 1 Mod 4 installed on torpedo course attachment, quintuple tube mount.



indicators. These motors position the inner dials of follow-the-pointer dial groups. The gyros in the torpedoes are set properly by turning the **basic-gyro-setting** hand crank at the tube mount until the gyro angle dials are matched. The torpedo tube mount is properly trained by turning the **training hand crank** at the torpedo tube mount until the one-and 36-speed torpedo course dials are matched. The torpedo tubes are correctly aimed when the torpedo course and gyro angle dials are matched with the signals transmitted from the torpedo director.

Figure 7-Telescope Mk 50 Mods 0 and 1.

Figure 8-Firing Key Mk 19 Mod 0.

latitude correction. Of these quantities, basic sight angle is the only unknown one, therefore, the director must solve for this basic sight angle before torpedo course can be determined.

Theoretically, the problem involved is to solve the triangle of torpedo fire.* See figure 9. In this triangle, the line of sight from own ship to target forms the base of the triangle. The length of this line is proportional to the range of the target. The target track and torpedo track form the other two sides of the triangle. Since the lengths of torpedo sight angle is computed in the director by the operation of the two component solvers, front and back, see figure 10. The front solver (target solver) from inputs of target course, target speed, own ship course and relative bearing produces Xt (target deflection component). The back solver (sight angle solver), with an input of torpedo speed, is rotated through an angle of Ds (sight angle) by the sight angle follow-up motor or the sight angle hand crank, until its output Xto (torpedo deflection) equals Xt. When Xt equals Xto, the high-and low-speed zero reader dials in the torpedo director are at zero. If these dials are off, they indicate that the Xt and Xto are not equal and that the correct sight angle has not been produced. For a more detailed description of how the torpedo director works, see chapter 3.

*To simplify the explanation and understanding of the torpedo fire-triangle problem, gyro angle, latitude correction, intercept offset and tube offset were omitted. However, in actual solution of the problem in the torpedo director, these quantities are taken into consideration in producing torpedo course orders.

INPUTS AND OUTPUTS

track and target track are proportional to the torpedo and target speeds respectively, these lines may be considered as representing torpedo and target speeds. Therefore, for a given target angle, the torpedo will intercept the target at point M. (This occurs, as shown in figure 9, when Xt (target deflection) is equal to Xto (torpedo deflection).

$$Xt = St \sin Bt$$
$$Xto = Sto \sin Ds$$

Thus, to secure a hit, Xt must equal Xto, when St Sin Bt Sto Sin Ds. From the above equation, Ds (basic sight angle) can be found, since the three remaining quantities (St, Bt and Sto) are known.

The torpedo director handles the problem in the form of the equation given above. Basic

The Torpedo Director Mk 27 has two electrical inputs, ten hand inputs, and two electrical outputs. See figure 146.

Electrical Inputs

One electrical input received by the director is **own ship course** (Co). It is received continuously at one-speed from the gyro compass system, and positions the one-speed own ship course zero reader dial. In case of power failure, own ship course can be introduced into the director by hand, see Hand Inputs below. The other electrical input, **relative target bearing** (Bs), is received at one-and 36-speed by the bearing receiver on the right side of the torpedo director. This electrical signal positions the inner dials of the one-and 36-speed follow- the-pointer dial group of the bearing receiver. The ring dials of the two dial groups are turned mechanically to match the inner dials by manually rotating the training handwheel of the torpedo director.

Hand Inputs

The 11 hand inputs to the torpedo director are:

(1) Own ship course (Co) is introduced by hand at 180-speed or 2 degrees per revolution of the hand crank. This quantity is introduced manually when there is power failure to the servo motor of the own ship course follow-up unit. In this case, the own ship course hand crank is turned to keep the zero reader dial matched at zero.

(2) Target speed (St)is introduced by hand at 10-speed or 2 knots per revolution of the hand crank. The director personnel receive this quantity by telephone from the ship's main plot or CIC. This quantity positions the speed spiral of the front solver (target solver). The target speed dial indicates the amount set into the director.

(3) Target course (Ct) is set in by hand at 90-speed or 4 degrees per revolution of the hand crank. The director operators also receive this quantity

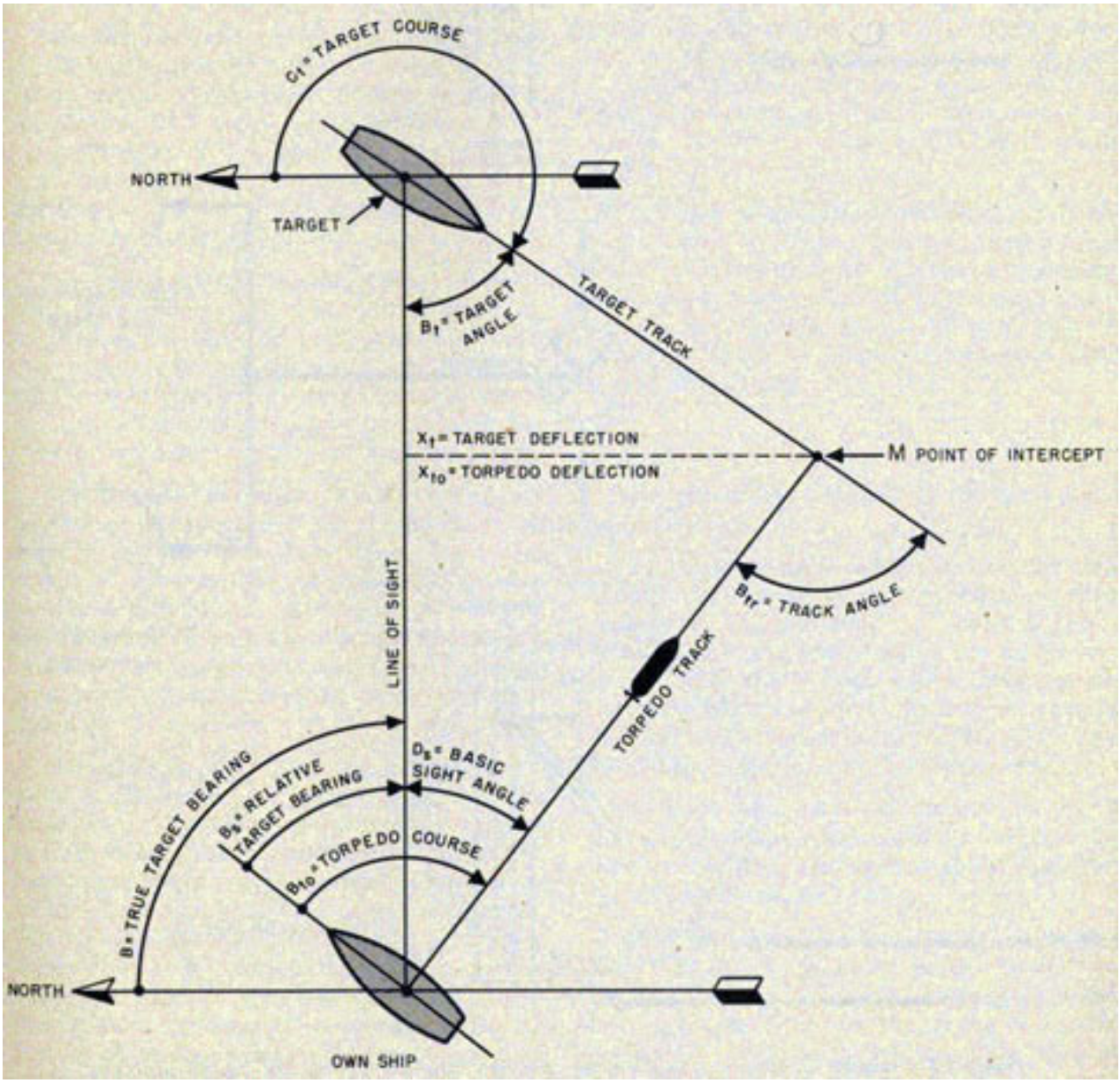


Figure 9-The triangle of torpedo fire.

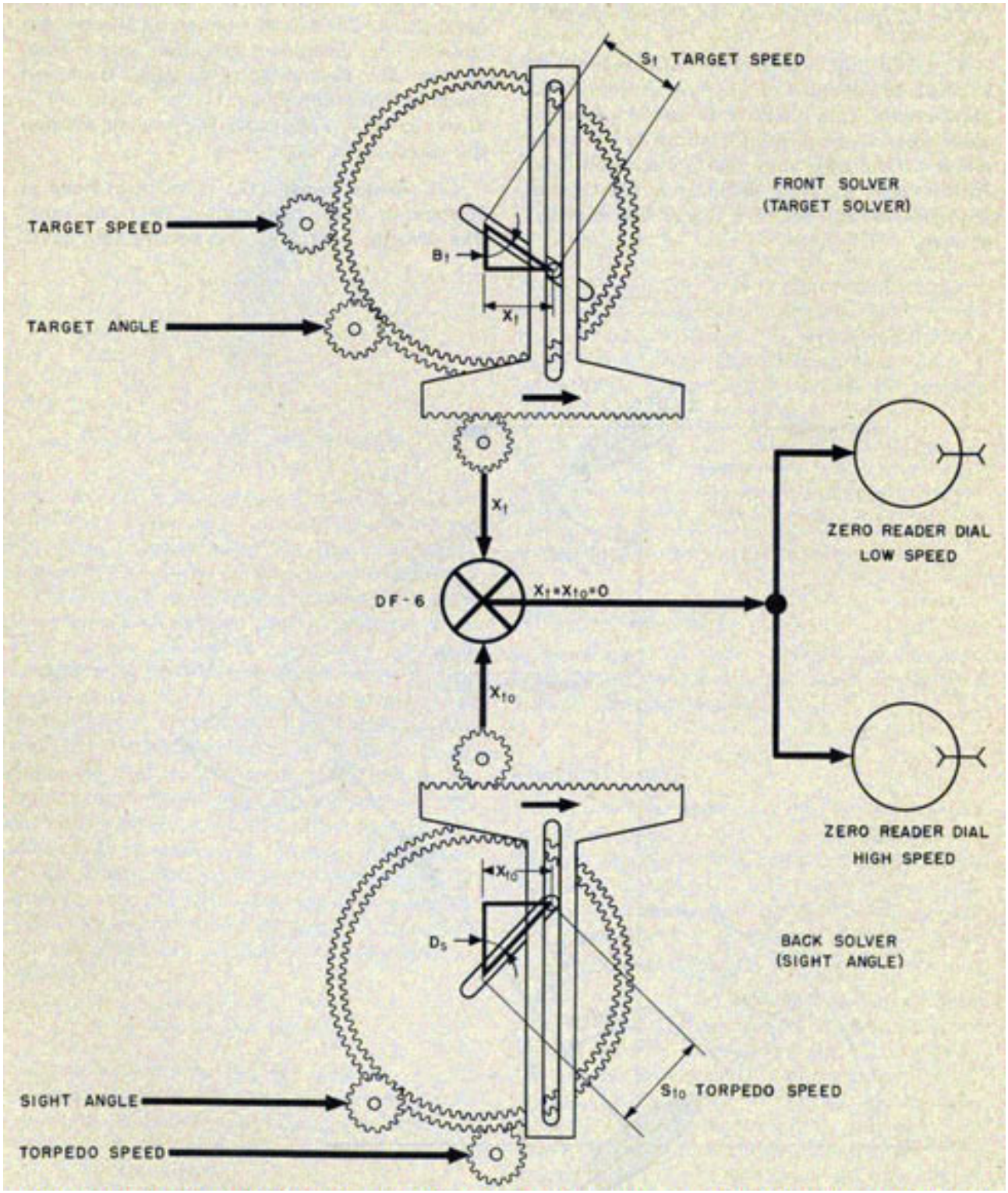


Figure 10-Diagram of computer angle solver position after computing fire control problem.

by telephone from the ship's main plot or from CIC. The target course input positions the angle gear of the front solver and the target angle dial.

(4) Torpedo speed (Sto) is introduced by hand at 10-speed or 2 knots per revolution of the hand crank. This is an arbitrary speed chosen for the torpedo problem set-up. The director is designed to solve for torpedo speeds from 0 to 50 or 60 knots. This quantity positions the speed spiral of the back solver and the torpedo speed dial.

(5) Torpedo course (relative) (Bto) is produced in the director by turning the training handwheel at 180-speed or 2 degrees per revolution for Mods 1, 2, 3, and 7 and at 120-speed or 3 degrees per revolution of the handwheel for Mods 4, 5, 8, and 9. Rotation of the handwheel positions the torpedo course synchro generators and the director computing mechanism.

(6) Relative Target Bearing (Bs) (director train plus sight angle) is introduced manually by turning the director train handwheel until the inner follow-the-pointer dials of the bearing receiver are matched. Relative target bearing can be obtained optically by training the director until the telescope bears on the target.

(7) Latitude Correction (Kla) is

(9) Tube offset (Otu) is introduced by hand at 180-speed or 2 degrees per revolution of the hand crank. Tube offset modifies the torpedo course order so that the forward tube mount is trained forward and the after tube mount is trained aft, or vice versa through an angle equal to the tube offset angle with respect to the basic torpedo course. The tube offset dial indicates in degrees the amount of offset introduced in the director.

(10) Gyro angle (Bgy) is introduced by hand at 72-speed or 5 degrees per revolution of the hand crank. This input positions the gyro angle dial and the two-speed synchro generator marked "E". This generator transmits gyro angle electrically at two-speed to the torpedo course indicator at the forward and after torpedo mounts.

(11) Sight angle (Ds) is introduced by hand at 180-speed or 2º per revolution of the hand crank. This quantity is introduced manually when there is power failure to the sight angle servo motor. In this case the hand crank is turned to keep the high-and low-speed zero reader dials at zero.

Outputs

The two electrical outputs of the torpedo director are:

(1) Torpedo course order (Bto) transmitted at one-and 36-speeds by the two sets of synchro generators. The generator "C" and the generator "A" transmit one-and 36-speed signals respectively to the torpedo course indicator on the forward torpedo tube mount, generators "B" and "D" transmit torpedo course to the after torpedo tube mount. See figure 146.

(2) Gyro angle (Bgy) is also transmitted to the torpedo course indicators at the torpedo tube mounts. It is transmitted at two-speed by the synchro generator "E".

Note: When the operators at the tube mounts turn their hand cranks to match the torpedo course dials and the gyro angle dials of the torpedo course indicators, they train the mounts correctly to hit the target and thus produce tube train.

introduced by hand at 180-speed or 2º per revolution of the knurled latitude correction wheel. One click equals 10 minutes. The magnitude of the correction depends upon the duration of the torpedo run and the latitude in which the torpedo is fired. The latitude correction dial indicates in degrees the amount of the correction introduced in the director.

(8) Intercept offset (Osi) is introduced by hand at 180-speed or 2 degrees per revolution of the hand crank. This input, an arbitrary correction, is introduced when it is desired to change the basic sight angle by some pre-determined value to take care of unexpected target maneuvers. The changes are made in the basic sight angle directly without altering the problem set-up. Intercept offset is generally introduced after one or more torpedoes have been fired. The intercept offset dial indicates the amount of offset introduced in the director.

Table I

DIFFERENCES BETWEEN MODIFICATIONS OF THE TORPEDO DIRECTOR MK 27

Mod	Maximum Torpedo Speed	Number of sets of one-and 36-speed Torpedo Course Synchro Generators	Training Handwheel Speed	Type of Bearing Receiver Used	Remarks
1	50 knots	2 sets	180-speed 2º/ Rev.	External lighting type (ORDALT 2107)	
2	50 knots	3 sets	180-speed 2º/ Rev.	External lighting type (ORDDALT 2107)	No tube offset provided for set of torpedo course generators controlling center torpedo tube mounts. Construction same as Mod 1.
3	60 knots	2 sets	180-speed 2º/ Rev.	External lighting type (ORDALT 2107)	Construction same as Mod 1.
4	60 knots	2 sets	120-speed 3º/ Rev.	External lighting type (ORDALT 2107)	Similar in appearance and construction to Mod 1. For description of bearing receiver see pages 54 to 61.
5	60 knots	2 sets	120-speed 3º/ Rev.	External lighting type (ORDALT 2107)	This is the production instrument. Similar to Mod 4. For bearing receiver see pages 54 to 61.

6	60 knots	2 sets	120-speed 3º/ Rev.	None	Experimental director, only one manufactured. Same as Mod 5 except contains square race dial gears.
7*	50 knots	2 sets	180-speed 2º/ Rev.	Internal lighting type	Mod 1 torpedo director with a bearing receiver attached, see pages 54 to 61.
8*	60 knots	2 sets	120-speed 3º/ Rev.	Internal lighting type	Mod 4 torpedo director with a bearing receiver attached, see pages 54 to 61.
9*	60 knots	2 sets	120-speed 3º/ Rev.	Internal lighting type	Mod 5 torpedo director with a bearing receiver attached, see pages 54 to 61.

*NOTE: Mods 7, 8, and 9 were assigned after internal lighting type bearing receivers were installed. All ships having these instruments are now in inactive status. Instrument nameplates are to be changed from Mods 1, 4, and 5 to 7, 8, and 9, respectively, by the ship's force at the time the ships are activated.

When tube offset has been set into the director, synchro generators "A" and "C" send out torpedo course modified for tube offset for the forward tube mount; synchro generators "B" and "D" transmit torpedo course modified for tube offset for the after tube mount.

DIFFERENCES BETWEEN MODS OF TORPEDO DIRECTOR

1787-Installation of red illumination for dials.

2107-Installation of relative target bearing receiver.

DIFFERENCES BETWEEN MODS OF THE TORPEDO COURSE INDICATOR

The Torpedo Course Indicator Mk 1 Mods 0 to 4 are somewhat similar in design, purpose, and function. All the instruments have dials which indicate torpedo course at one-and 36speed, torpedo course order at one-and 36speed, gyro angle and gyro angle order at two-speed, except Mod 3, and tube train at one-speed.

The Torpedo Directors Mk 27 Mods 1 to 9 are similar in purpose, function, and operation. They all require the same type of inputs and all have the same outputs, torpedo course, and gyro angle. The main differences between the various mods are: (1) the maximum torpedo speed that can be set in the director, (2) the number of sets of one-and 36-speed torpedo course synchro generators, (3) the speed of the training handwheel and telescope drive and (4) the type of bearing receiver used. The main differences between the various mods of the torpedo director are listed in table 1, page 12.

NavOrd Ordalts Applicable

1255-Instructions for installing centering device for sight angle motor follow-up.

The major difference between the various mods are: (1) the type of supply used for dial illumination (separate six-volt supply or six-volt supply from transformer in instrument), (2) the number of synchro motors used, (3) the type of gyro angle dials used, (4) the use of plug boards in the lightwell wiring, and (5) the use of a three-ampere fuse in the lightwell wiring. These differences are summarized in table 2, page 13 for the various mods of the torpedo course indicator.

Table 2

DIFFERENCES BETWEEN MODS OF THE TORPEDO COURSE INDICATOR MKI MODS 0 TO 4

Instrument	Number of synchro motors	Receives gyro angle order electrically	Has separate six-volt dial illumination supply	Has dial illumination transformer	Has plug board in lightwell wiring	Has three-ampere fuse in lightwell wiring
Mod 0	3	yes	no	yes	yes	no
Mod 1	3	yes	no	yes	no	no
Mod 2 (original)	3	yes	no	yes	no	yes
Mod 2 (later)	3	yes	yes	no	no	no
Mod 3*	2	no	no	yes	no	yes

Mod 4	3	yes	yes	no	no	no

*The major difference between the Mod 3 and the other indicators is that the Mod 3 is not provided with the two-speed gyro angle synchro motor and the gyro angle follow-the-pointer dials. In the Mod 3, the follow-the-pointer dials are replaced with a single gyro angle dial which indicates gyro angle in degrees set into the gyros of the torpedoes.

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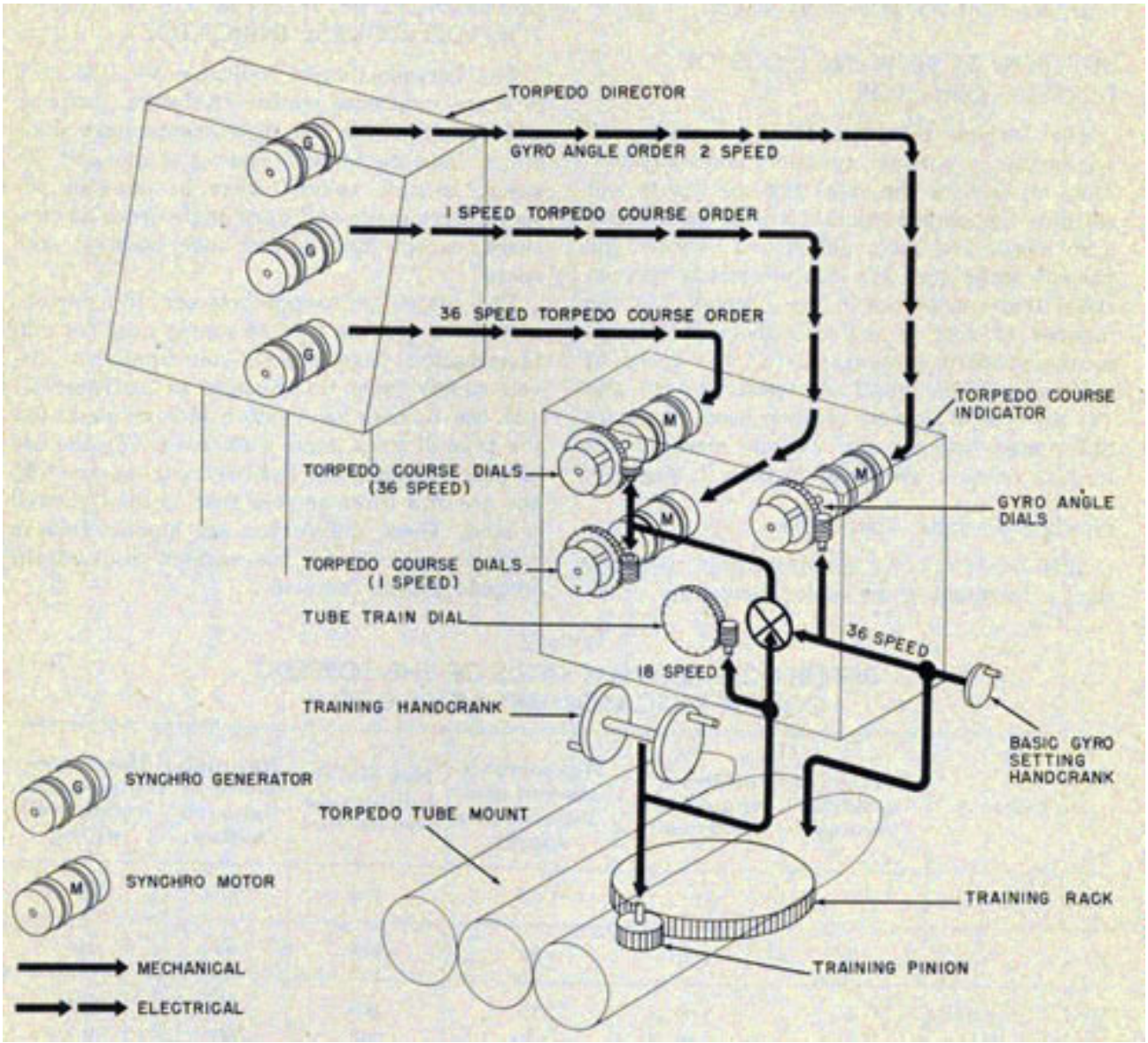

Figure 11-Functional diagram showing course of inputs and outputs through the Torpedo Course Indicator Mk 1 Mods 0, 1, 2 and 4.

Chapter 3

FUNCTIONAL DESCRIPTION

HOW THE TORPEDO DIRECTOR MK 27 WORKS

In this section, the overall internal operation of the Torpedo Director Mk 27 Mods 1 to 9 is described. For information on how each individual unit of the torpedo director works, refer to the particular section describing the unit in the Description Chapter.

Figure 146, functional diagram for the torpedo director, shows the path of the various quantities through the torpedo director. In order to simplify the description of how the director works, each quantity will be discussed to show its travel through the director and what part it contributes in producing torpedo course.

Relative Target Bearing

This quantity is received electrically by the one- and 36-speed synchro motors in the bearing receiver. As shown in figure 146, this quantity positions the inner dials of the follow-the-pointer dial groups. To get the director on the designated target, these dials are matched against the ring dials by turning the training handwheel.

If all the dials of the director are set at zero, rotation of the training handwheel will: (1) train the director case and the telescope as a unit, (2) position the middle dial of main dial group "A" via differential DF-3 to indicate relative target bearing, (3) position the rotors of two sets of one- and 36-speed torpedo course synchro generators an amount equal to relative target bearing, and (4) position the torpedo course dials to indicate this quantities or known factors of the torpedo control problem must be introduced into the torpedo director.

Own Ship Course

This quantity, received electrically at one-speed, positions the own ship course zero reader dial. In normal operation, rotation of the rotor of the own ship course synchro motor operates the follow-up mechanism which controls the operation of the servo motor. Rotation of the servo motor, positions the own ship course dial and sends own ship course (Co) to differential DF-2. Here, own ship course is combined with relative target bearing (Bs) to produce true target bearing (B).

For a complete description of how the own ship course receiver works, see page 45.

True target bearing positions the outer ring dials of the main dial groups "A" and "B" and goes through differential DF-2.

Target Speed

The target speed crank is turned to introduce the proper target speed in the torpedo director. Rotation of this crank does two things: (1) it positions the target speed dial which indicates the amount of target speed set in, and (2) positions the speed gear (spiral-cam plate) of the front solver. Rotation of the spiral plate positions the pin (cam follower) away from the center of the plate, a distance proportional to target speed. The intermittent gear limit stop limits target speed input from 0 to 50 knots.

bearing.

In actual operation, this is not the case. Briefly, the input of relative target bearing, introduced by the training handwheel, is combined with corrected sight angle and tube offset to produce the torpedo course necessary to hit the target. Therefore, before the correct torpedo course can be produced, all the necessary

Target Course and Target Angle

Target course (Ct) is introduced into the director by rotation of the target course knob. This input goes to differentials DF-1 and DF-2 where it is combined with true target bearing to produce target angle (Bt).

Target angle positions the middle dial of the main dial group "A" and the angle gear of the front solver. Rotation of the angle gear drives the output rack, by means of the pin, to produce target deflection (Xto) which goes to differential DF-6.

Target angle also positions the spiral gear via the compensating differential DF-4. The purpose of this differential is to prevent the position of the pin from changing as the angle gear is rotated. For a complete description of the component solver and the compensating differential, see page 35.

Torpedo Speed

The torpedo speed crank is turned to introduce, through DF-5, the proper torpedo speed (Sto) into the torpedo director. Rotation of this crank does two things: (1) it positions the torpedo speed dial which indicates the amount of torpedo speed set in, and (2) it positions, through DF- 5, the speed gear (spiral-cam plate) of the back solver. Rotation of the spiral plate positions the pin (cam follower) away from the center of the plate a distance proportional to torpedo speed.

The limit stop limits torpedo speed input from 0 to 50 knots for Mods 1, 2, and 7 and from 0 to 60 knots for Mods 3, 4, 5, 6, 8 and 9.

the zero-reader dials to zero. In other words, the algebraic sum of Xt and Xto equals zero.

Sight Angle

Rotation of the sight angle servo motor produces sight angle which does three jobs: (1) sight angle via differential DF-9 trains the telescope away from the target an angle equal to the sight angle, (2) positions the basic sight angle dials, and (3) positions the angle gear of the back solver, until a value of Xto is produced that is equal to Xt. When Xto equals Xt, the follow-up mechanism is zeroed and the servo motor stops rotating.

Note: In case of power failure to the servo motor, the sight angle hand crank can be used to take the place of the servo motor. In this case, the crank must be turned to keep the high-and-low-speed zero reader dials zeroed.

The limit stop switch shown in figure 35, controls the operation of the servo motor when sight angle is at its extreme limits.

Torpedo Course

Torpedo course is produced when the director trainer turns the training handwheel to bring the

Torpedo Deflection and Target Deflection

Assuming that the angle gear of the back solver is at its zero position, the output of the solver, torpedo deflection (Xto) would be zero. If it were at any other position a certain amount of torpedo deflection would be produced. This quantity Xto is sent to differential DF-6 where it is compared with target deflection (Xt). If both quantities are equal, there is no output of the differential and the high-and-low-speed zero reader dials remain zeroed.

If the two quantities are unequal, the differential algebraically adds the two quantities to form an output. This output does two things: (1) it displaces the zero reader dials from their zero position, and (2) it operates the follow-up mechanism which controls the sight angle servo motor (telescope train motor) which restores telescope back on the target. Rotation of the handwheel positions the rotors of the two sets of one- and 36-speed torpedo course synchro generators, the torpedo course dials, and the check dials.

This torpedo course does not include latitude correction, intercept offset or tube offset. These corrections are introduced into torpedo course as follows:

Latitude Correction

Latitude correction is produced when the latitude knob is turned to set the latitude correction dial. The correction is introduced in the instrument, when the intercept offset crank is turned to match the intercept dial with the latitude correction dial.

Intercept Offset

When the intercept offset crank is turned to introduce either latitude correction or intercept offset, it trains the telescope via differential

DF-9 an additional amount equal to the correction and also positions the front and back solvers. Thus, differential DF-9 combines basic sight angle with this correction to produce corrected sight angle.

Corrected Sight Angle

This corrected sight angle trains the telescope, and positions the corrected sight angle dial and the inner dials of the main dial group "A" and "B"

Here again, when the training handwheel is turned to bring the telescope back on the target, the

The purpose of the torpedo course indicator is to enable the tube mount personnel to train the tube mount and set the gyro angle on the torpedoes in accordance with the electrical torpedo course and gyro angle orders from the director.

Inputs

The indicator has four inputs: (1) torpedo course received electrically at one- and 36-speed, (2) gyro angle received electrically at two-speed, (3) tube train received mechanically at 18-speed and, (4) gyro angle received mechanically at 36-speed. See figure 11.

torpedo course corrected for latitude correction and intercept offset is produced.

Tube Offset

Tube offset is introduced when the tube offset crank is turned. Rotation of the crank positions the tube offset dial and is transmitted to differentials DF-7 and DF-8 where torpedo course is modified for tube offset. The outputs of DF- 7 and DF-8 position the torpedo course synchro generators which transmit the torpedo course corrected for tube offset to the torpedo course indicators.

Gyro Angle

Gyro Angle is produced when the gyro angle crank is rotated to position the gyro angle dials. Rotation of the crank is transmitted to position the rotor of the gyro angle synchro generator. This generator transmits gyro angle electrically at two-speed to the torpedo course indicators.

In actual operation of the torpedo director, several of the above operations are going on at the same time. Therefore, torpedo course is being produced continuously by the torpedo director as the problem progresses.

HOW THE TORPEDO INDICATOR MK I WORKS

The Torpedo Course Indicators Mk 1 Mods 0 to 4 are similar in purpose and operation. Each indicator is secured to a torpedo course attachment which is mounted on the top of the torpedo tube mount. See figure 6.

The indicator is equipped with dials to show torpedo course, gyro angle, and tube train.

The Torpedo Course Indicator Mk 1 Mod 3 is equipped with only two synchro motors which receive torpedo course. The Mod 3 indicator does not receive gyro angle electrically.

Figure 11, functional diagram of the Torpedo Course Indicator Mk 1 Mods 0, 1, 2, and 4, illustrates the path of inputs through the instrument.

1. Torpedo course received electrically at one- and 36-speed, positions the inner dials of the torpedo course follow-the-pointer dials.

2. Gyro angle received electrically at two-speed positions the inner dial of the gyro angle follow-the-pointer dial.

3. Gyro angle received mechanically at 36speed from the gyro setting mechanism performs two actions: (1) it positions the ring dial of the gyro angle follow-the-pointer dials to match the inner dial, and (2) it forms one input to the differential. When the gyro angle dials are matched the gyros in the torpedoes are properly set.

4. Tube train received mechanically at 18speed from the tube mount rack as the mount is trained, also results in: (1) positioning the tube train dial to indicate the actual train of the tube mount, and (2) forming the other input to the differential. The differential algebraically adds gyro angle to tube train to produce torpedo course.

Torpedo course, output of the differential, mechanically positions the ring dials of the

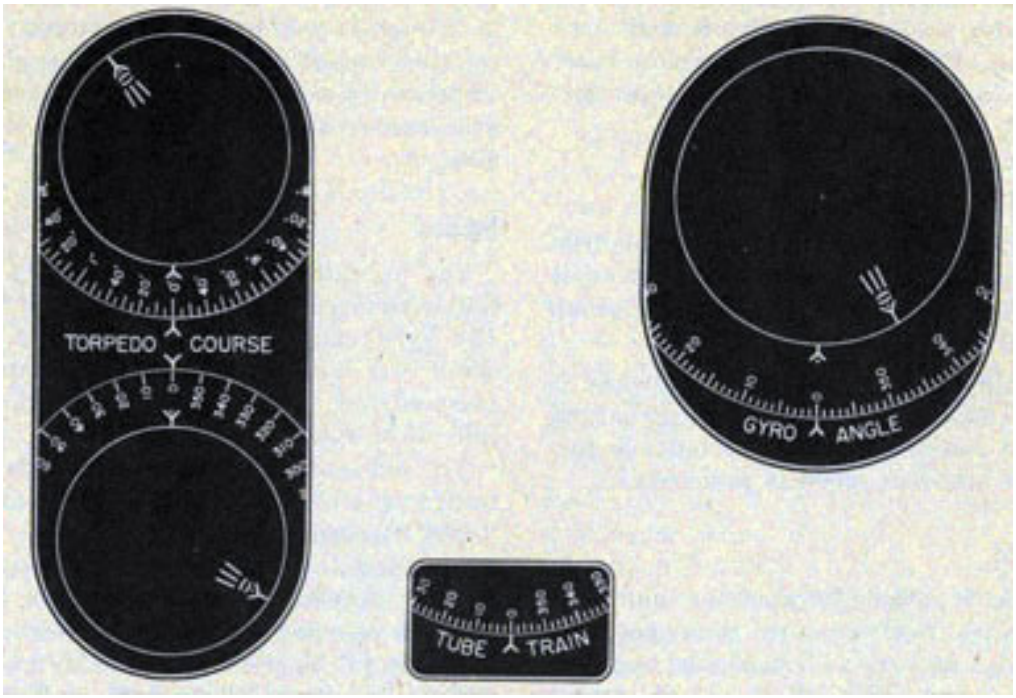

Figure 12-Appearance of Torpedo Course Indicator dials alter torpedo course and gyro angle orders have been received from the torpedo director.

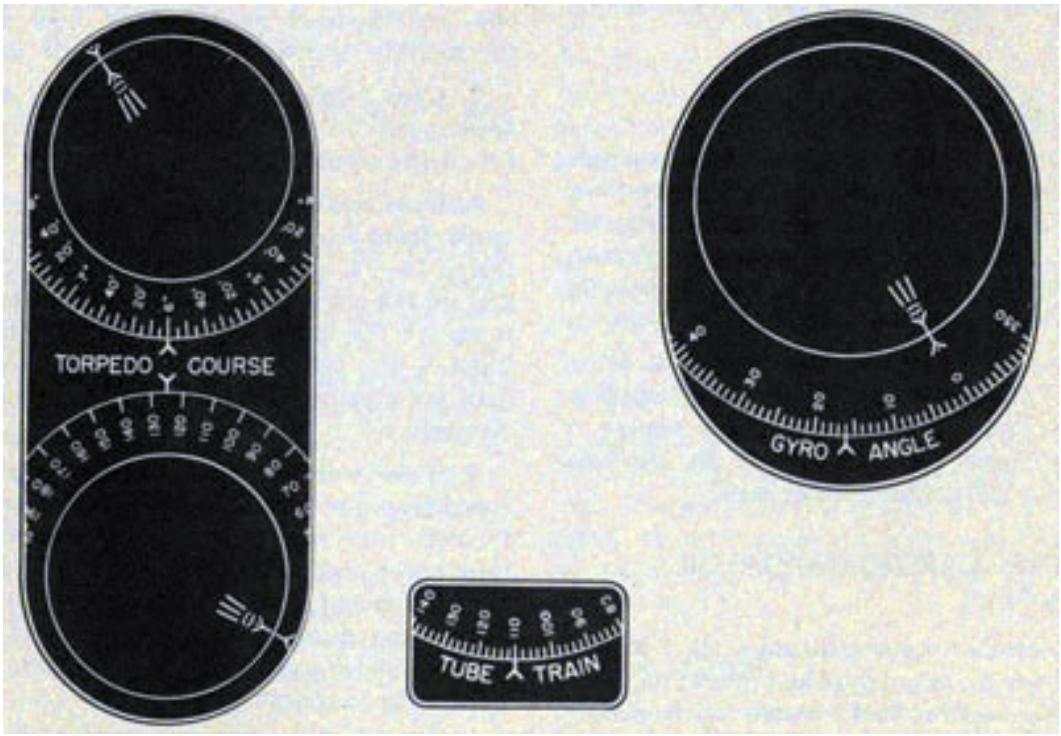

Figure 13-Appearance of Torpedo Course Indicator dials after tube mount has been trained to execute torpedo course order and gyro angle has been properly set on torpedoes.

torpedo course follow-the-pointer dials to match the inner dials. When the torpedo course dials are matched, the torpedo tube mount is properly trained. See figure 13. To operate the indicator properly the gyro angle dials and the torpedo course dials must be kept matched at all times in order to launch the torpedoes on the correct course.

How to Read the Dials of the Indicator

The Torpedo Course Indicator Mk 1 Mods 0, 1, 2, and 4 is equipped with three sets of dials: (1) the one- and 36-speed torpedo course follow-the-pointer dials, (2) gyro angle follow-the-pointer dials, and (3) the tube train dial.

The Torpedo Course Indicator Mk 1 Mod 3 is also equipped with three sets of dials. However, unlike the other mods the gyro angle dial is a single mechanically driven dial that indicates the amount of gyro angle set into the torpedoes.

Torpedo Course Dials. The torpedo course dials consist of an inner dial, positioned by torpedo course received electrically from tie torpedo director, and a ring dial positioned mechanically by the output of the differential in the torpedo course indicator.

Figure 12 illustrates how the dials appear when the torpedo course indicator is receiving a typical torpedo course order from the director. Observe that the inner dials have moved away from their zero position and that their indexes are not in alignment with the indexes of the ring dials. This indicates that the torpedo tube mount has not been trained to carry out the order.

Figure 13 illustrates how the dials appear when the torpedo tube mount has been trained to execute the torpedo course order. The indexes of the ring dials match the indexes of the inner dials.

2, and 4 consist of an inner dial, positioned by gyro angle order, received electrically from the torpedo director, and a ring dial positioned mechanically by the basic gyro setting hand crank.

Figure 12 illustrates appearance of the dials when the indicator is receiving a typical gyro angle order from the torpedo director. Observe that the inner dial is away from its zero position and that the index of the inner dial is not in alignment with the index of the ring dial.

Figure 13 shows how the dials appear when the basic gyro setting hand crank has been turned to match the index of the ring dial with the index of the inner dial. When the dials are matched, the gyros are properly set in the torpedoes. The reading of the ring dial against the fixed index indicates the gyro angle is 16 degrees.

The single gyro angle dial of the Mod 3 indicator is positioned mechanically by the rotation of the basic gyro angle hand crank of the gyro setting mechanism. The graduations on this dial are the same as those on the gyro angle dial for Mods 0, 1, 2, and 4. The Mod 3 dial indicates in degrees the gyro angle set on the gyros in the torpedoes.

Tube Train Dial. This dial is positioned mechanically, degree for degree, as the torpedo tube mount is trained. The tube train dial indicates the actual train of the torpedo tube mount relative to own ship.

Figure 13 illustrates the appearance of the dial when the torpedo tube mount is trained 110 degrees.

HOW THE TELESCOPE MK 50 WORKS

The main purpose of the telescope is to enable the director trainer to train the director on a visible target and to keep the director trained on the target as corrected sight angle is being produced in the

The ring dials when read against the fixed indexes show that the torpedo course order received from the torpedo director is 126 degrees. As illustrated, the one-speed dial indicates approximately "120" degrees and the 36speed dial indicates "6" degrees. Therefore, the exact reading is 126 degrees.

Gyro Angle Dials. The gyro angle dials of the Torpedo Course Indicator Mk 1 Mods 0, 1, director. See figure 7.

The Telescope Mk 50 Mod 0 and 1 is of the tilting mirror type. As the ship rolls and pitches the line of sight is kept on the target by means of the mirror elevating knob which positions the mirror in the telescope. Figure 14 is a schematic diagram of the telescope. This view shows the path of light through the lens system.

The ray filters in the telescope are shifted by rotation of the ray filter knob mounted on the top of the telescope. The ray filters provided are "CLEAR", "RED", "YELLOW", "LIGHT NEUTRAL", and "DARK NEUTRAL". The crosslines of the telescope are illuminated by means of a lamp. The intensity of the crossline illumination is controlled by the crossline illumination rheostat mounted on top of the torpedo director case. This rheostat provides for three conditions "DIM", "OFF", and "BRIGHT".

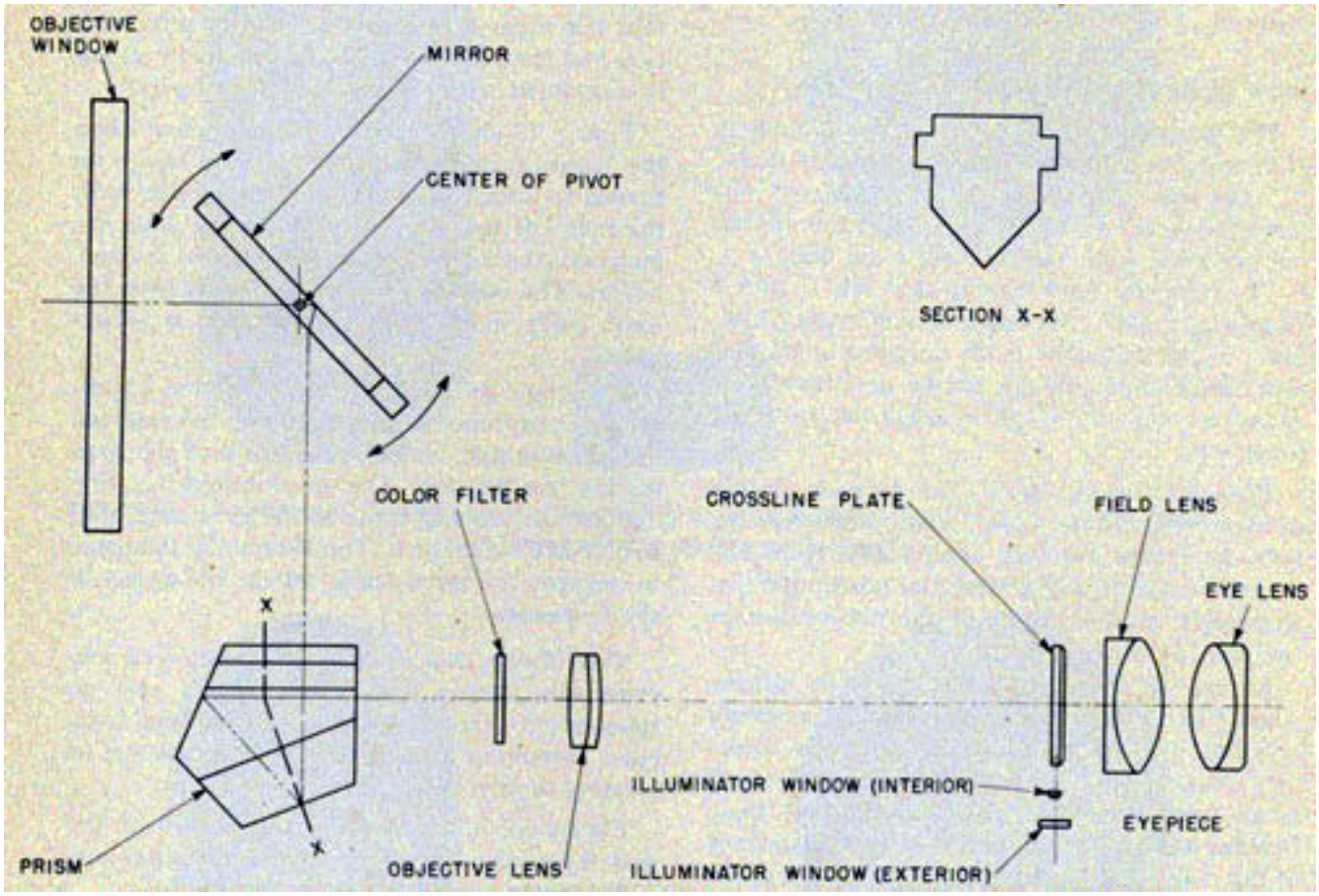

Figure 14-Telescope Mk 50 optical diagram.

Chapter 4

OPERATION

The operation procedure and related information presented in this chapter are compiled from current standard destroyer doctrine and should serve as a guide which can be varied according to type of ship, personnel available, material conditions and the ship's doctrine set down by the ship's commanding officer.

PERSONNEL REQUIRED

Theoretically, the Torpedo Director Mk 27 Mods 1 to 9 can be operated by two men, but in actual operation three or four men are used. They are: (1) torpedo officer, (2) director trainer, (3) selector switch operator, and (4) telephone talker. See figure 15.

Figure 15-Torpedo officer, director trainer and telephone talker operating torpedo director.

Torpedo Officer

The torpedo control officer is responsible, under the commanding officer, for the efficient operation and maintenance of the torpedo control system and the torpedo battery. The torpedo control officer will see that firing and synchro transmission circuits are tested frequently. His station is at the engaged torpedo director. He is usually free to consult with the commanding officer concerning favorable track angles, unmasking the battery, and torpedo speed settings. When firing torpedoes from both sides of the ship, by utilizing both torpedo directors, the officer of the deck and the director trainer man one torpedo director and the torpedo control officer and the selector switch operator man the other.

When the target is designated by the commanding officer, the torpedo officer's usual duties are:

1. Orders "**Torpedo action port (starboard)**". Designates the target and approximate bearing to the director trainer and tube personnel.

2. Orders type of fire, bridge control or local control. Director control is further indicated by order, "**Match pointers**".

3. Orders depth setting in feet.

4. Informs director trainer and tube personnel of number of torpedoes in spread, torpedo speed, unit of spread, and tube mount offset.

orders "**stand-by**" then "**Fire one**", "**Fire two**", etc.

11. Orders "**Selective aim, right to left (left to right)**" so the director trainer can choose firing points in the order given. In addition to the above, he also keeps the tube personnel informed of:

1. The relative bearing and appearance of the target.

2. The target angle and speed.

Director Trainer

The director trainer mans the torpedo director and its firing key on the engaged director. In actual operation of the torpedo director, the director trainer performs the following duties:

1. Sets torpedo speed, target speed, and target course into the torpedo director.

2. He trains the torpedo director on the target by looking through the telescope and turning the training handwheels until the crosslines bear on the target. He can also train the director on an invisible target by turning the training handwheel to match the dials of the bearing receiver.

3. Sets gyro angle into the torpedo receiver as ordered.

4. Makes any other setting or correction as directed.

5. Makes reports such as: "**Director set**"; "**On target**" or "**On radar bearing**"

6. Fires torpedoes with firing key as directed with three second intervals.

Selector Switch Operator

The selector switch operator, at the director, operates the selector and firing switches. He operates own ship course hand crank in case of power failure. The following duties are performed by the selector switch operator:

Note: Speed setting is the commanding officers decision.

5. Informs director trainer of target course and speed.

6. Informs tube personnel of target angle and speed.

7. Checks tube train and gyro angle to insure firing on safe bearing and maintains control of gyro angle at the director. **Note**: The torpedo officer must know the gyro angle setting so that he can select the proper intercept offset and torpedo speed corrections.

8. Orders re-adjustment, if necessary, for director set-up.

9. Makes sure that the target is within the effective range.

10. Reports, "**On target**", to commanding officer. When directed by commanding officer,

1. Maintains immediate contact over the telephone with the torpedo tube mount operators.

2. Relays, by telephone, target designation, target angle, target speed, torpedo speed, depth setting, unit of spread, and tube offset to the torpedo tube mounts.

3. Informs the tube mount operators of the number of torpedoes in salvo.

4. Operates selector firing switches, reporting by telephone, to the tube mounts, "Fire one, fire two", etc.

Telephone Talker

Serves as torpedo control officer's talker and performs duties of trainer and selector switch operator in case of casualties to personnel.

For a complete description of the duties

are positioned by true target bearing. **Note**: True target bearing is made up of own ship course and relative target bearing. The outer ring dial of the dial groups "A" when read against the fixed index indicates the true target bearing. In this case, the dial indicates a true target bearing of "90 degrees", that is, the angle between the north and the line of sight to the target, measured clockwise from the north.

of the various operators used in the torpedo control system, see current D.T. B. (confidential) "Destroyer Torpedo Doctrine and Manual of Torpedo Control".

HOW TO READ THE DIALS OF THE TORPEDO DIRECTOR

To simplify the understanding of the dial readings and what they represent, a typical torpedo control problem is given below. Dial readings are illustrated and an explanation of the values they represent in the torpedo control problem is given.

For example, take the problem of a destroyer, which is on course 40 degrees when an enemy ship is sighted at a range of approximately 6,000 yards. The estimated target course and speed are 210 degrees and 30 knots respectively. See figure 16. The torpedo control officer orders tube mount personnel to "**Standby**" for curved fire with a spread gyro angle of 4 degrees between torpedoes.

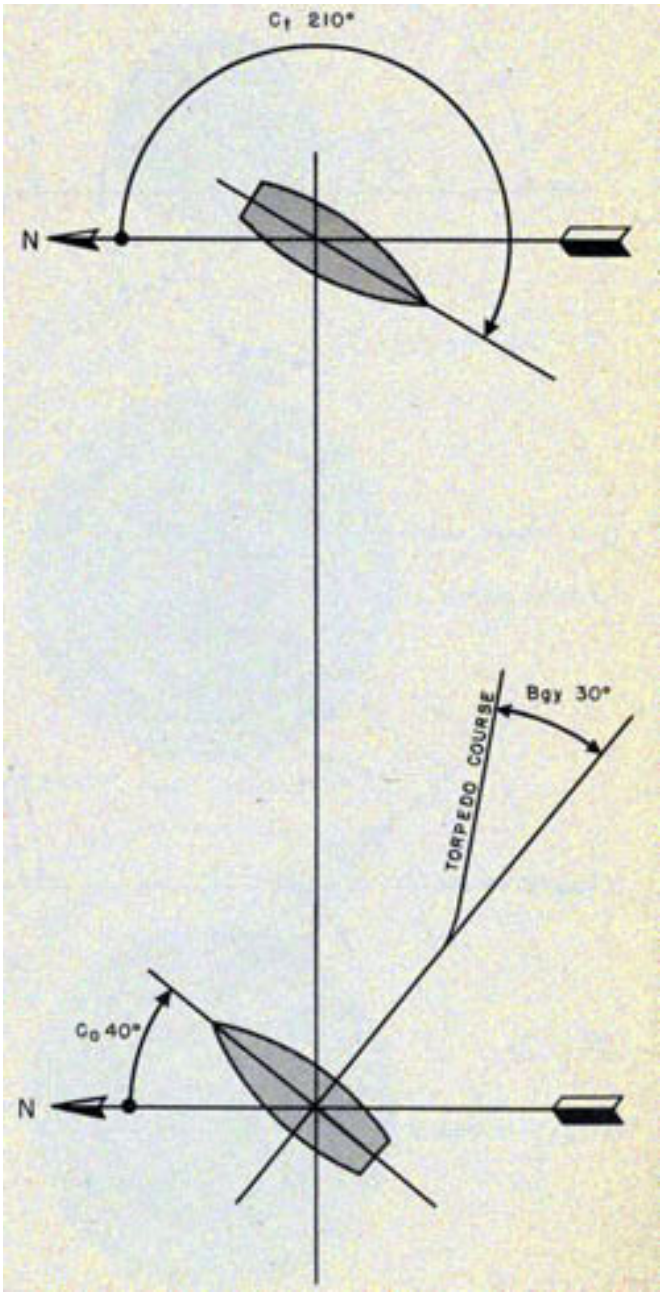

Figure 16-Typical torpedo problem.

He also may decide to use a 30 degrees gyro angle, a 10 degrees tube offset and a torpedo speed of 40 knots. These values are immediately cranked into the starboard torpedo director by the director trainer.

The director trainer also cranks into the torpedo director the target course (210degrees) and the target speed (30 knots) as relayed to him by the torpedo control officer.

Main Dial Groups

Figure 17 illustrates the torpedo problem as it now appears on the main dial groups. The fixed straight line joining the centers of the main dial groups represents the line of sight. Both outer ring dials have a zero degree graduation which indicates true north. These dials

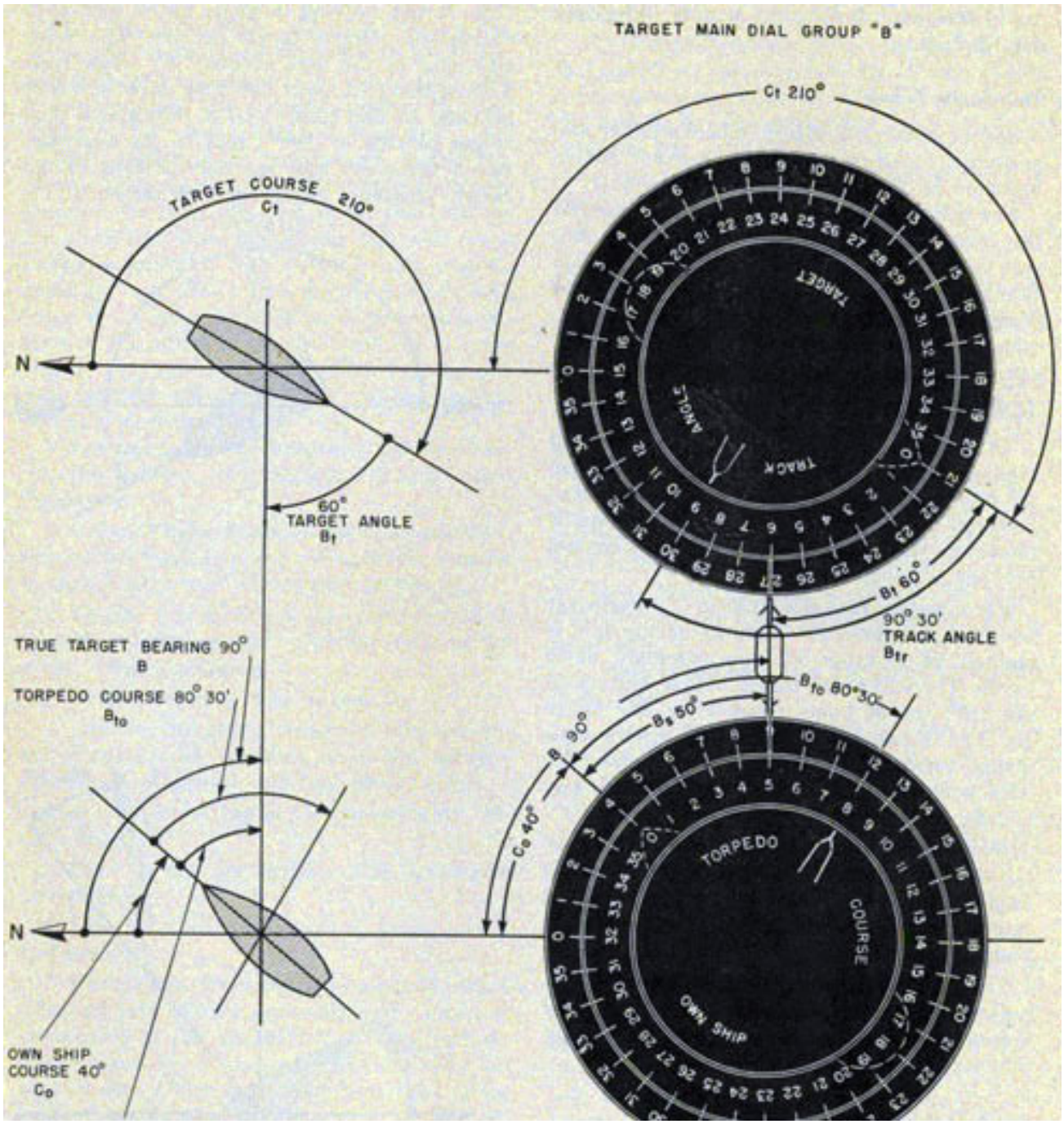

Figure 17-Main dial group of torpedo director.

OPERATION

The middle ring dials of dial groups "A" and "B" have the outline of a ship engraved on them. When the middle ring dial zero index (bow of ship) of the dial group "A" is read against the outer ring dial, it indicates own ship course; "40 degrees" for this set-up. When the middle dial is read against the fixed index, it indicates a relative bearing of "50 degrees". When the zero index of the middle ring dial of the "B" group is read against the outer ring dial, it

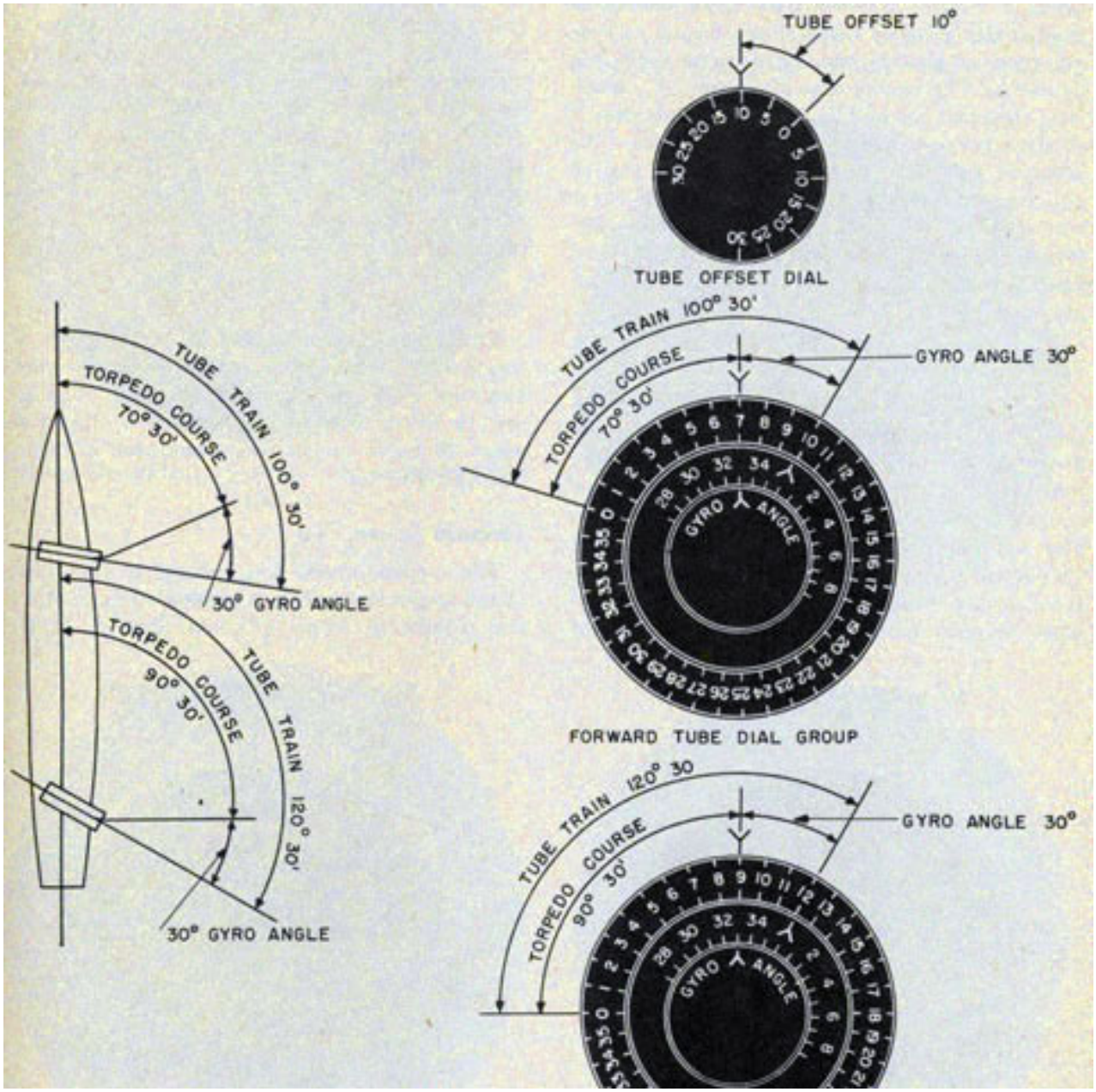

Figure 18-Appearance of tube offset and tube dials.

indicates a true target course of "210 degrees". When this middle dial is read against the fixed index it indicates a target angle of "60 degrees".

The center dials of the dial groups "A" and "B" are positioned mechanically by the corrected sight angle that is produced within the director. Note: Corrected sight angle cannot be read directly from these dials, but it can be obtained by reading the sight angle dials, see figure 22. The center dial of group "A", when read against the middle ring dial, indicates a relative torpedo course (uncorrected for tube offset of 80 degrees-30'). True torpedo course can be obtained by reading this dial against the outer ring dial. In this case, the reading is 120 degrees-30'. When the center dial of group "B" is read against the middle ring dial, it indicates a track angle of 90 degrees-30'.

Tube Offset and Tube Dials

Figure 18 illustrates the three dial groups to the left of the main dial groups of the torpedo director. The upper dial, the tube offset dial, indicates a reading of "10 degrees" tube offset (starboard) as ordered by the torpedo control officer. The remaining dial groups are for the tubes. The upper group is for the forward torpedo tube mount and the bottom group is for the after torpedo tube mount. The center dial of each of these groups is a fixed dial and serves as an index for the middle or gyro angle dial.

The middle dial is positioned mechanically by the gyro angle hand crank and indicates the gyro angle setting to he made on the torpedoes. In this setup, the middle dials when read against the index of the center dial, indicate a reading of "330 degrees". The outer ring dials indicate the torpedo course order transmitted to the torpedo course indicators at the tube mounts. **Note**: This torpedo course order includes tube offset. Therefore, with a tube offset of 10 degrees (starboard) the torpedo course dial (upper dial group) for the forward torpedo tube mounts reads 70 degrees-30' and the dial for the after torpedo tube mount reads 90 degrees-30'.

Target Speed Dial

The target speed dial, located to the right of the main dial groups, is graduated every knot and numbered every 5 knots from 0 to 50. Figure 19 illustrates the appearance of the dial when 30 knots target speed has been cranked into the director.

Torpedo Speed Dial

The torpedo speed dial, located to the right of the target speed dial, is graduated every knot and numbered every 5 knots from 0 to 60

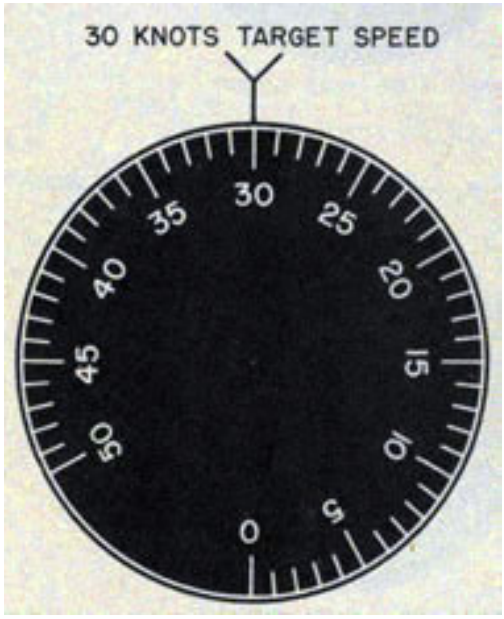

Figure 19-Target speed dial.

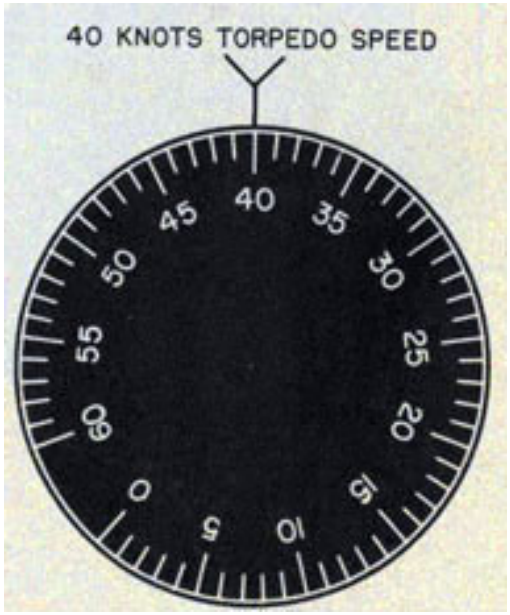

Figure 20-Torpedo speed dial.

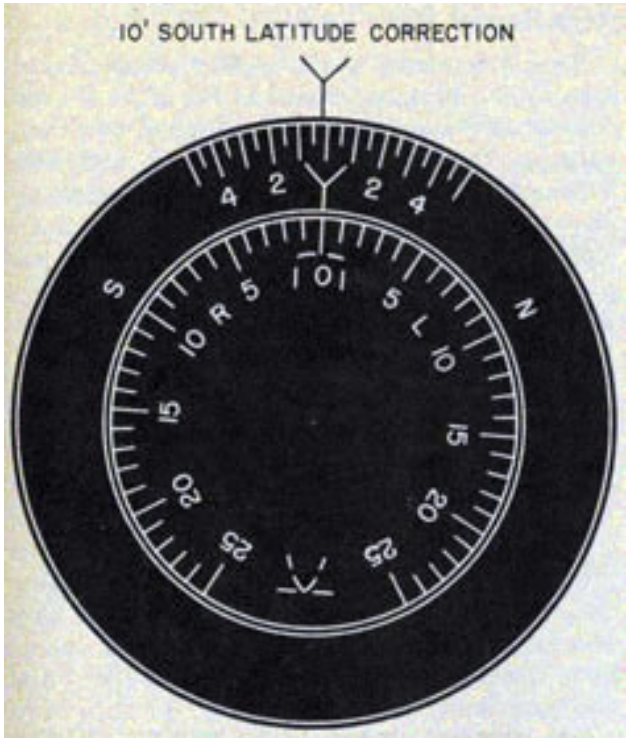

Figure 21-Latitude correction and intercept offset dial.

knots. For Mods 1, 2, and 7 the dials are graduated from 0 to 50 knots. Figure 20 illustrates how the dial appears when 40 knots torpedo speed has been introduced.

Intercept Offset and Latitude Correction Dial Group

The above dials, located beneath the target speed dial, consist of an inner and outer dial.

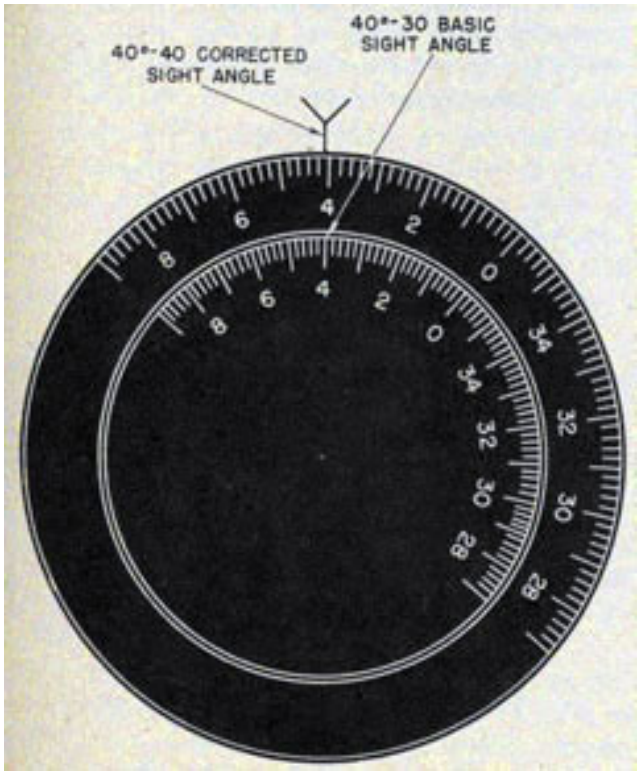

Figure 22-Corrected sight angle.

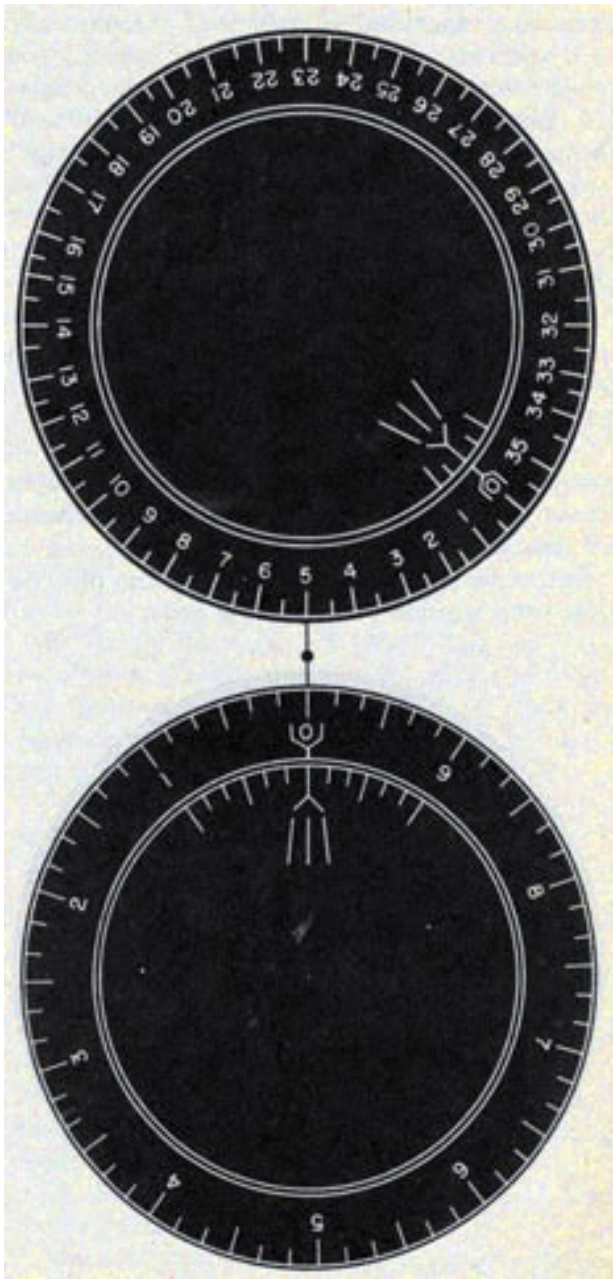

Figure 23-Relative target bearing dials.

The outer dial is the latitude correction dial, and the inner ring dial is the intercept offset dial. Figure 21 illustrates the dial readings when 10' south latitude correction and zero degrees intercept offset have been cranked into the torpedo director.

Sight Angle Dials

The sight angle dials, located beneath the torpedo speed dial, consist of an inner and outer dial. The inner dial is positioned mechanically by basic sight angle. The outer dial is positioned mechanically by corrected sight angle. Figure 22 shows how the dials appear when 40 degrees 30' basic sight angle and 40 degrees 40' corrected sight angle have been produced in the torpedo director.

Relative Target Bearing Dials

The relative target bearing dials, located in the bearing receiver, consist of a one- and 36-speed follow-the-pointer dial group. Each set of dials consists of an inner dial, positioned by the electrical target bearing signal, and an outer dial, positioned mechanically to match the inner dial. Figure 23 illustrates the appearance of the dials when the instrument receives a relative target bearing of 50 degrees and the director has been trained to match the order.

Zero Reader Dials

The zero reader dials, located on the right side of the director case, consist of high- and low- speed dials which are positioned mechanically by the difference between Xt and Xto. When Xt equals Xto, the dials are zeroed as shown in Figure 24. These dials are automatically zeroed by the follow-up mechanism in the director. In case of power failure to the follow-up mechanism, the dials are maintained at zero by turning the sight angle hand crank.

Own Ship Course Dials

The own ship course dials, also located on the right side of the director case, consist of a zero reader dial mounted on the rotor of the own ship course synchro motor and a one-speed dial which is driven mechanically by own ship course gearing in the director. In normal operation, the zero reader dial and the one-speed dial are positioned automatically by the own ship course follow-up unit in the director. In case of power failure to the follow-up unit, the own ship course hand crank must be turned to keep the zero-reader dial continuously matched at zero. Figure 25 illustrates how the dials appear when the torpedo director is receiving an own ship course signal of 40 degrees.

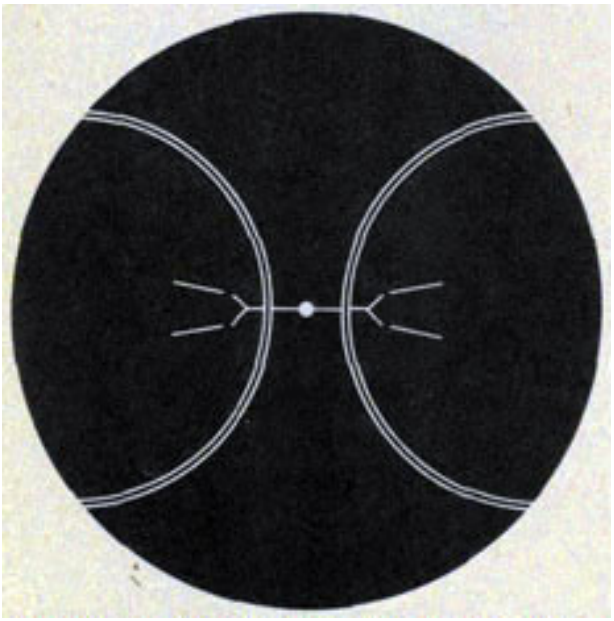

Figure 24-Zero reader dials.

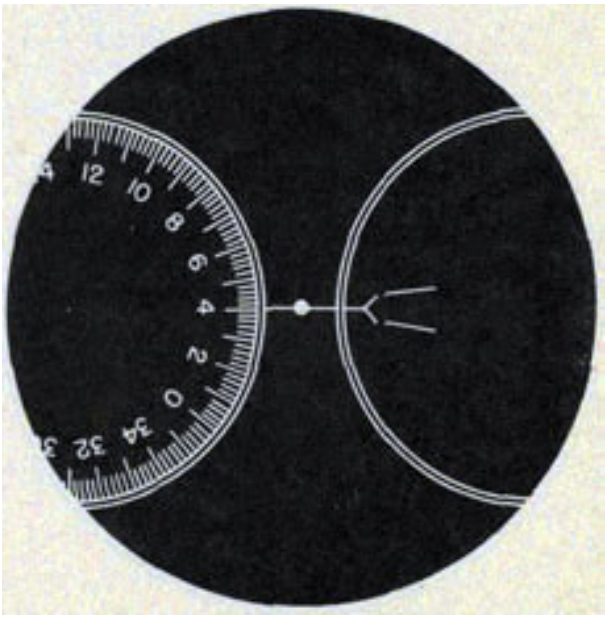

Figure 25-Own ship course dials.

SOURCE OF INFORMATION FOR INPUTS

The commanding officer informs evaluators in CIC and the torpedo control officer of: (1) target by type and true bearing, (2) number of torpedoes to be fired, (3) torpedo speed setting to be used, and (4) the firing point.

Evaluators in CIC inform both the commanding officer and the torpedo control officers of: (1) best estimate of target course and speed (from information obtained from DRT, main battery plot, radar, and from other sources or the mean value of all sources), (2) present range, (3) estimate of time when target will come within effective range for each torpedo speed, (4) when target comes within effective range at each torpedo speed, (5) when target has gone outside of effective range for each speed, and (6) furnishes relevant corrections for intercept offset and torpedo speed.

Relative target bearing obtained electrically from

2. Turn on the power supply to the director and the torpedo control system at the fire control switchboard. Also, turn on the director heater supply.

3. Turn the bridge transfer switch to "PORT" or "STARBOARD".

4. Turn the director selector switch to "ON" and illumination switch to "TRANSFORMER".

The torpedo director is now ready to track a target. In setting up a problem on the torpedo director, the following procedure is suggested:

1. Train the director on the target by turning the training handwheel (2) to match the dials of the bearing receiver or to bring the telescope sight to bear on the target.

2. Set the sight angle crank (3) and the own ship course hand crank (4) to "OUT" position.

CIC is indicated on the inner dials of the bearing receiver. The director is trained on the target when the director trainer turns the training handwheel to match the bearing receiver dials. If the target is visible, the director trainer can pick up the target by turning the training handwheel until the vertical crossline of the telescope intersects the target.

Own ship course is received electrically by the torpedo director where a follow-up mechanism converts it automatically into a mechanical input. In case of power failure, the own ship course zero reader dial must be set at zero by means of the own ship course hand crank.

OPERATION ROUTINE

This section will outline a suggested operation routine for putting the torpedo director into operating condition. This routine may vary somewhat with different ships depending upon ship's doctrine. In the following outline, the numbers in parentheses refer to the hand cranks that are numbered correspondingly in figure 147.

1. After removing the tarpaulin cover, set in latitude correction, each morning, by turning the latitude correction knob (1). This can be done by the officer with the morning watch.

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Note: In case of power failure, these hand cranks should be left in the "IN" position. As the problem progresses, the own ship course hand crank must be turned to keep the zero reader dial at "0" and the sight angle hand crank must be turned to keep the high and low speed zero reader dials matched at "0".

3. Introduce tube offset by turning the tube offset crank (5).

(4) Introduce refined latitude correction by turning the knob (1) to correct for torpedo creep.

5. Match the intercept offset dial, with the reading on the latitude correction dial by turning hand crank (6). Set intercept offset as necessary to correct for torpedo turning circle when firing shots with large gyro angles.

6. Crank in torpedo speed by turning the torpedo speed hand crank (7).

7. Introduce gyro angle, as directed by the torpedo control officer, by turning the gyro angle crank (8).

8. Introduce target speed by turning the target speed hand crank (9).

9. Set target course into the director by turning the target course hand crank (10). Then train director on target using the telescope sight or by matching the dials of the bearing receiver.

10. Fire the torpedoes, as directed, by closing the firing key (11).

The following procedure is suggested for securing the torpedo director:

TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE) OP 1586

1. Train the torpedo director to its stowed position, relative bearing

2. Set all the dials of the torpedo director to zero by turning the various hand cranks.

3. Turn the director selector switch and the illumination switch to "OFF".

4. Turn the bridge transfer switch and the heater switch to "OFF".

5. Turn off the power to the torpedo director at fire control switchboard.

6. Cover the torpedo director with tarpaulin provided.

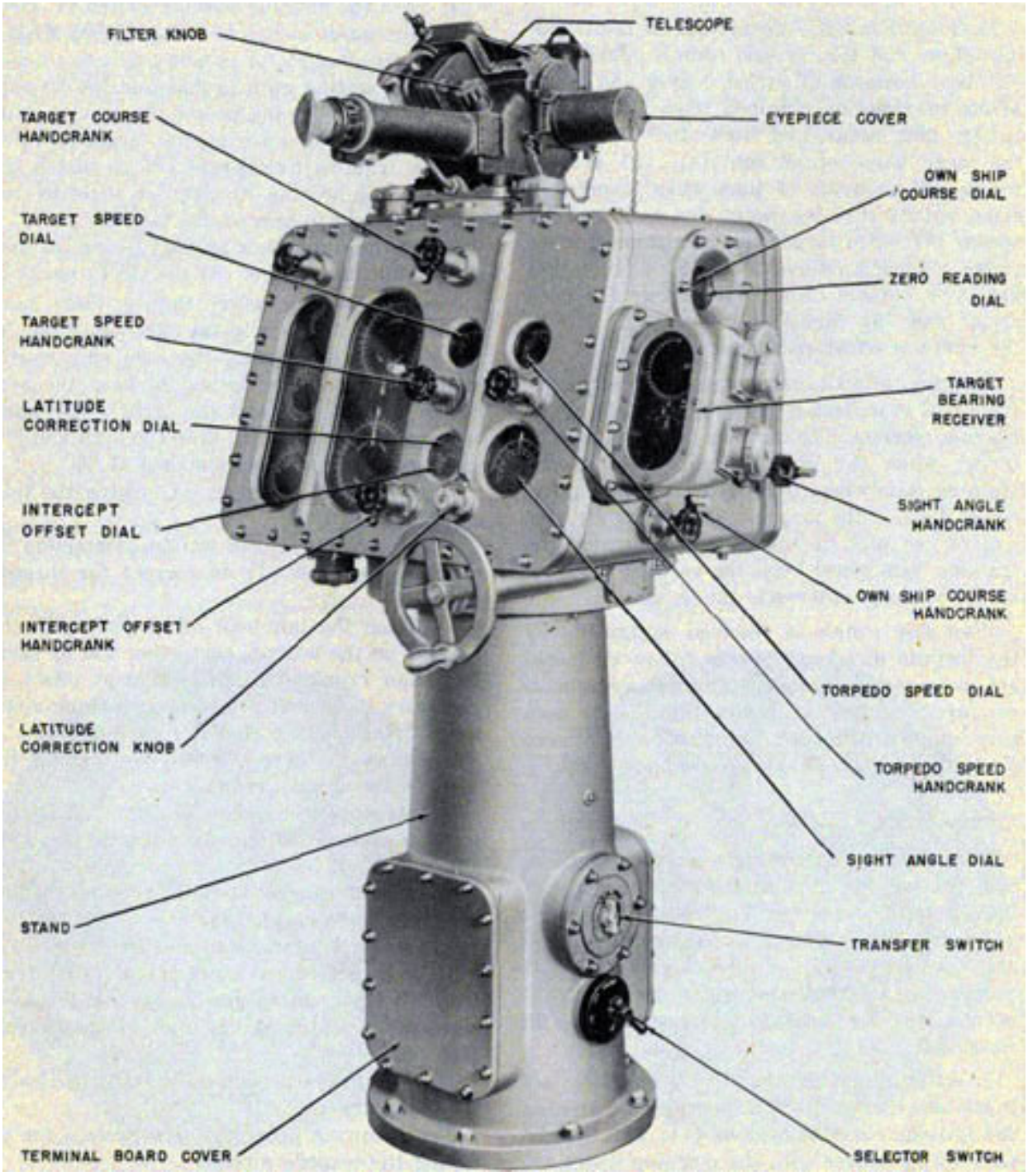

Figure 26-Front right view Torpedo Director Mk 27 Mod 5.

Next Part

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Chapter 5

DESCRIPTION

TORPEDO DIRECTOR

The Torpedo Directors Mk 27 Mods 1 to 9 are somewhat similar in appearance, function, and operation. They all calculate torpedo course and transmit torpedo course order and gyro angle order electrically to the torpedo course indicators at the torpedo tube mounts. Since Mods 4 and 5 are the most numerous modifications, they will be described in detail. The difference between the other mods and the Mods 4 and 5 are explained in table 1 page 12.

Physical Appearance

The torpedo director consists of two main assemblies: (1) the rotating case and (2) the stand. See figures 26 and 27.

The rotating case contains all the dials and the hand cranks, supports the Telescope Mk 50 Mods 0 and 1, supports the crossline rheostat unit, and houses the computing mechanism of the director. The stand supports the rotating case and houses the power supply selector switch and the illumination transfer switch. See figure 28.

The torpedo director together with the telescope is approximately 5 feet 6 inches high from the deck. The rotating case is approximately 3 feet 9 inches wide by 2 feet 5 inches from the front to the back. The stand is approximately 14 inches in diameter with an 18-inch base flange.

The front of the case consists of a large cover plate which has glass covered openings that give view to the own ship and target main dial groups "A" and "B" respectively, the tube offset dial, the torpedo course and gyro angle dials for forward and after torpedo tube mounts, the torpedo and target speed dials, and the latitude correction, speed, torpedo speed, intercept offset, target course, and latitude correction.

The training handwheel is located below the latitude correction knob. Mounted on the left side of the case are the fuse box and the gyro angle hand crank. On the right side of the case are the own ship course hand crank and dials, the high-and low-speed zero reader dials, the bearing receiver, and a lightwell which provides illumination for these dials.

The telescope pivot which supports the telescope and the firing key is mounted on top of the case. The crossline illumination rheostat, mounted on the top of the case controls the intensity of illumination for the crossline of the telescope. Four lightwells, two mounted on the top and two on the bottom of the case, provide illumination for the various dials on the front of the case. A large cover on the rear of the case, when removed, provides access to the internal mechanism. See figure 28.

Component Parts

The principal assemblies of the torpedo director are: (1) the rotating case, (2) the computer, (3) the own ship course assembly, (4) the transmitter, (5) the back post, (6) the bearing receiver, (7) the crossline illumination rheostat, (8) the telescope pivot, (9) the hand crank assemblies, (10) the dial assemblies, and (11) the stand.

Rotating Case. The cast aluminum-alloy case, figure 30, forms the watertight housing for the computer, the transmitter and the own ship course units. In addition, the case forms a rectangular platform for the mounting of the bearing receiver and telescope.

The front side of the case is made up entirely of a cover secured to the frame of the case by studs and

intercept offset and sight angle dials. See figure 29. Also on this same cover are the input hand cranks for tube offset, target acorn nuts. Glass covered openings have been provided in the front cover for the tube offset, torpedo course and gyro angle dials for the forward and after torpedo tube mounts,

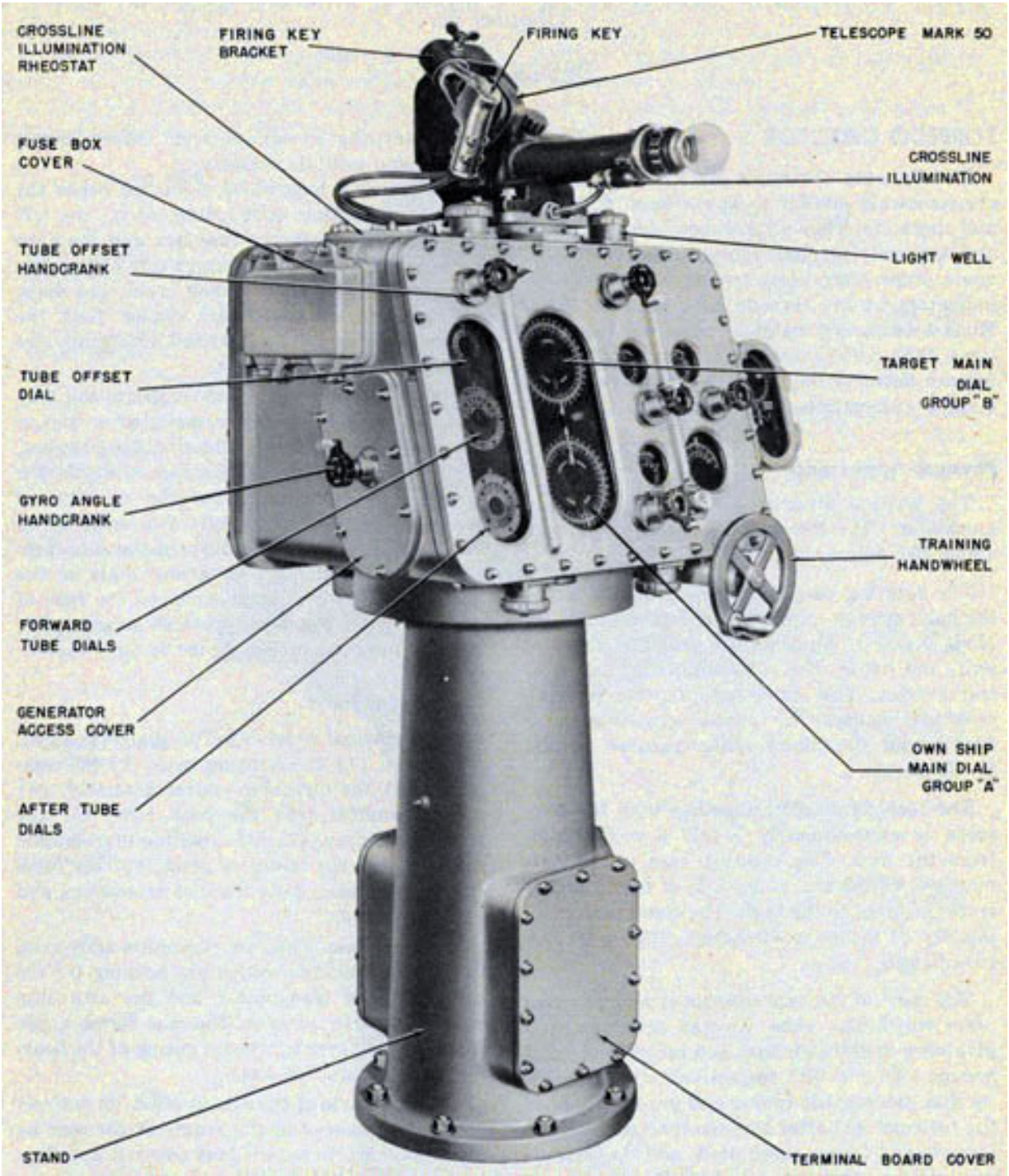

Figure 27- Front left view Torpedo Director Mk 27 Mod 5.

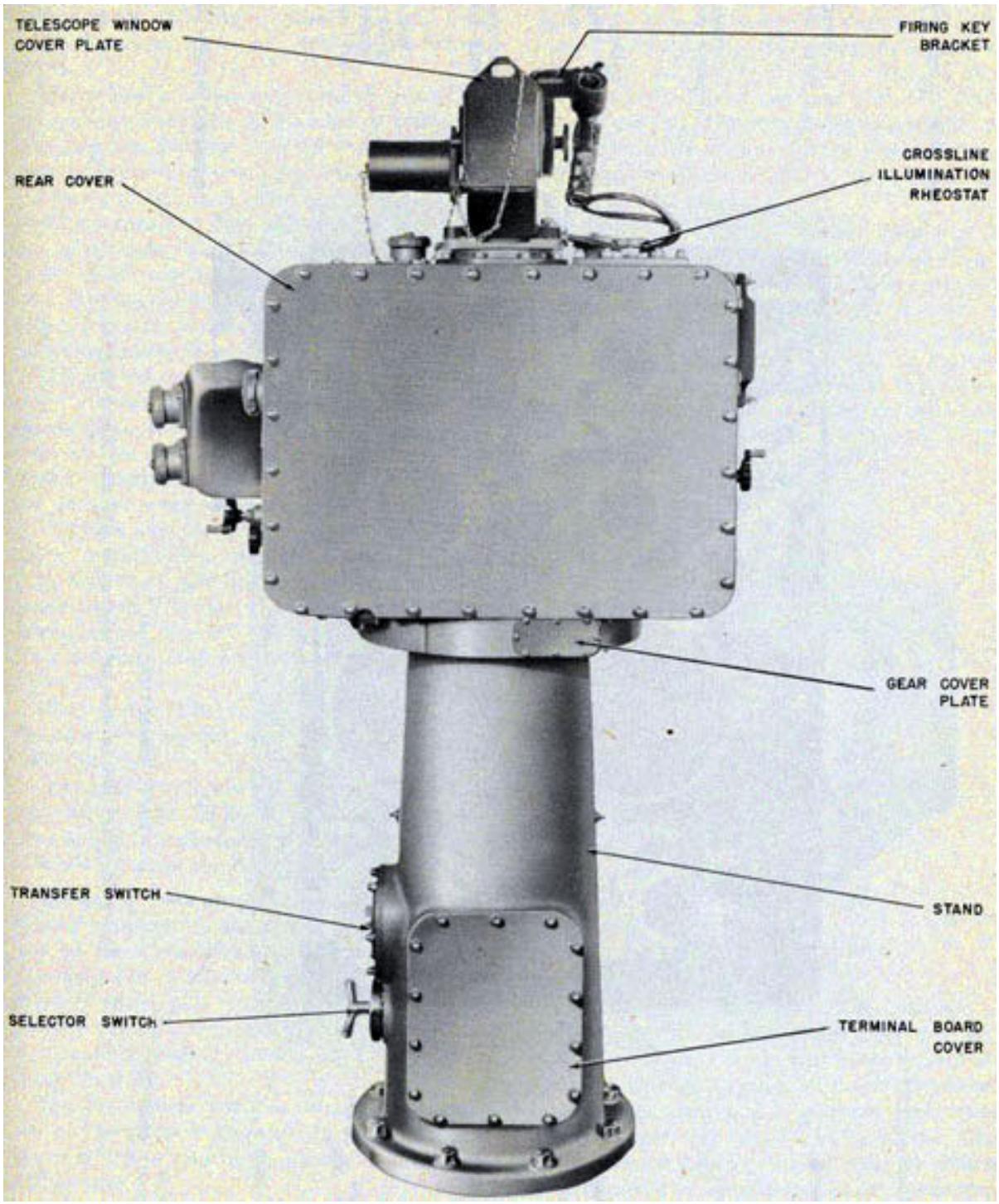

Figure 28-Back view of Torpedo Director Mk 27 Mod 5.

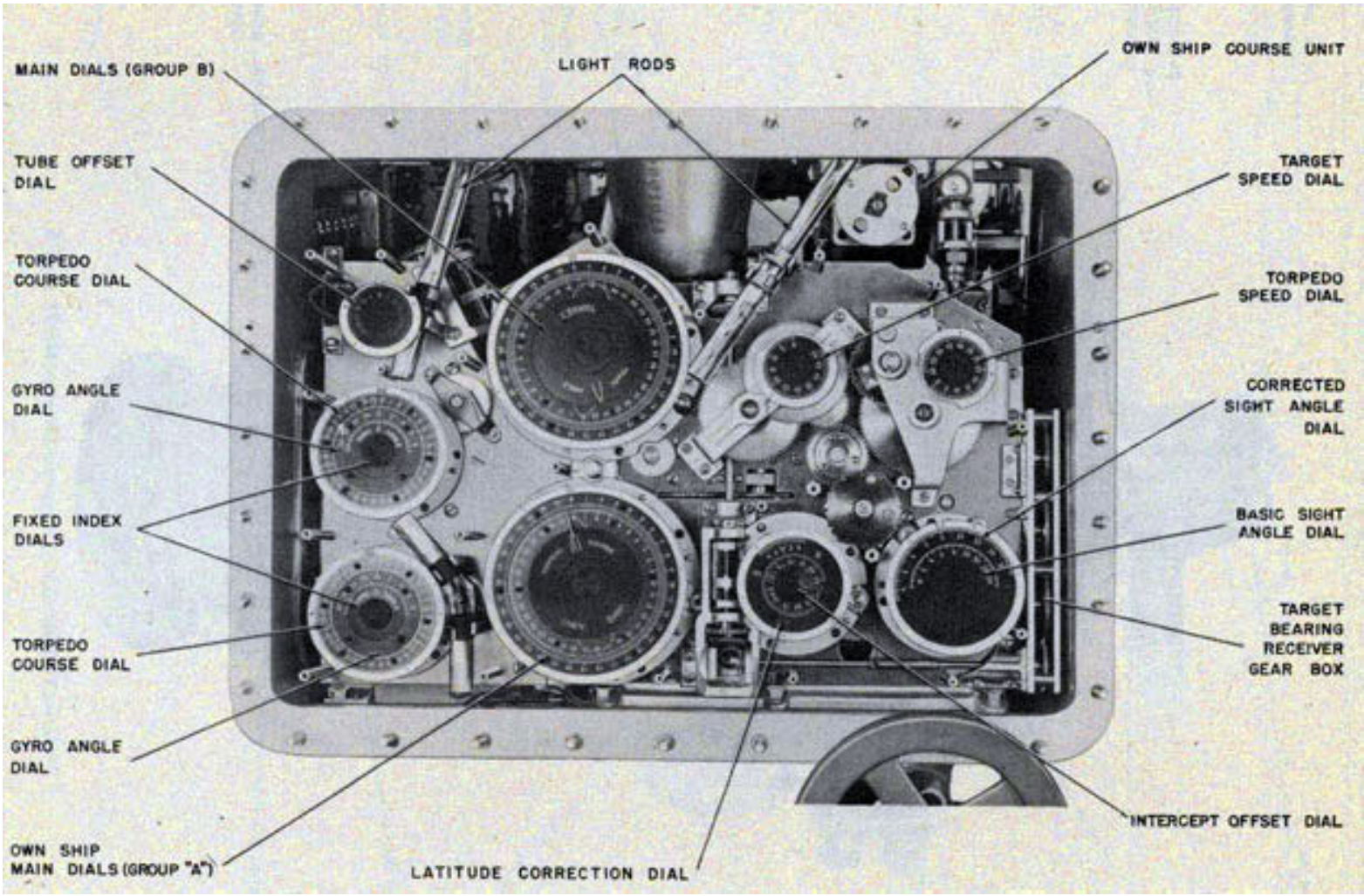

Figure 29-Front view of director case, cover and dial shields removed.

own ship and target main dial groups "A" and "B", torpedo and target speed dials and sight angle, intercept offset and latitude correction dials.

The training handwheel, located below the lower-right front side of the case, is connected by means of shafting through the base of the case to the training worm. See figures 26 and 50.

The right side of the case contains glass covered openings for own ship course dials And the zero reader dials. This side also contains pads which support

The computer assembly consists of nine separate units or sub-assemblies: (1) chassis, (2) angle-solver assembly, (3) sight-angle (follow-up) motor, (4) follow-up switch, (5) back plate assembly, (6) differential gear box, (7) shafting and gearing, (8) stop mechanisms, and (9) heating unit. These nine units or sub-assemblies are described in the following paragraphs. See figures 31 and 148.

CHASSIS. This cast aluminum-alloy unit is the frame to which the various sub-assemblies of the computer are attached. The chassis is roughly cubical in form. The front portion, directly back of the main dial group, slopes backward from the base at an angle of 15 degrees. Six mounting lugs extend beyond the bottom members of the chassis and provide the means for securing the chassis to the bottom of the rotating case. See

the sight angle and the own ship course hand cranks. The bearing receiver assembly is attached to this side of the case. See figures 26 and 53.

The left side of the case contains the fuse box cover, secured by wing nuts for ready removal. Spare fuses are stored inside the cover. This side of the case also contains the generator access opening cover which provides mounting for the gyro angle hand crank. See figure 27.

The back side consists of a large blank cover which is secured to the case frame by acorn nuts and studs. On this same side, is a small cover which provides access to the spur gear (mounted on the BTO-2 shaft) that meshes with the fixed training gear of the stand.. See figure 28.

The top side of the case contains the crossline illumination rheostat, two lightwells and the telescope pivot.

A total of five lightwells, each equipped with two Navy type TS-20 6-8 volt bayonet-base type lamps, are mounted on the case and provide illumination for the various dials.

Computer Assembly. The computer is the largest assembly in the rotating case. It occupies at least two-thirds of the interior space. The computer as a unit receives six inputs: (1) torpedo speed, (2) target speed, (3) target course, (4) own ship course, (5) latitude correction and intercept offset, and (6) relative target bearing.

The mechanical portions of this unit make use of these inputs to calculate figures 31 and 37.

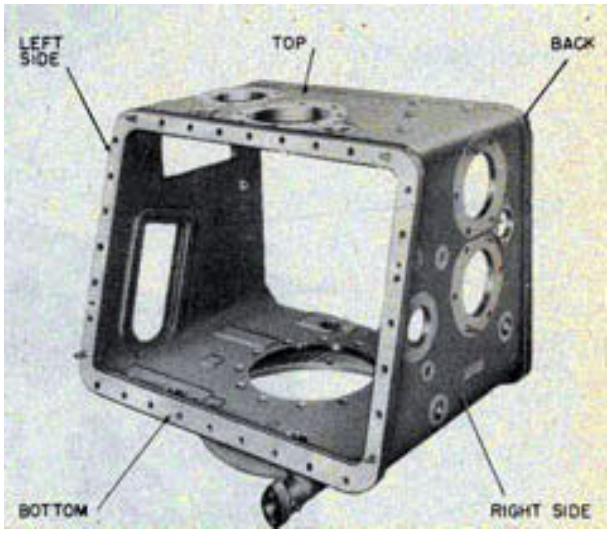

Figure 30-Rotating case.

ANGLE SOLVER ASSEMBLY. This assembly is made up of two solvers, each consisting of a cam, a vector gear, a pin and follower, and one T rack supported between front and back solver plates. Each cam has a constant lead spiral groove. These cam plates are called the speed gears because they are turned until the desired target speed and torpedo speed are in alignment with the respective dial settings. One revolution of the cam plate is the equivalent of 20 knots. See figures 32 and 33.

torpedo course order which is sent mechanically to the transmitter unit.

The computer automatically compensates for any or adjustment made in any of the six inputs.

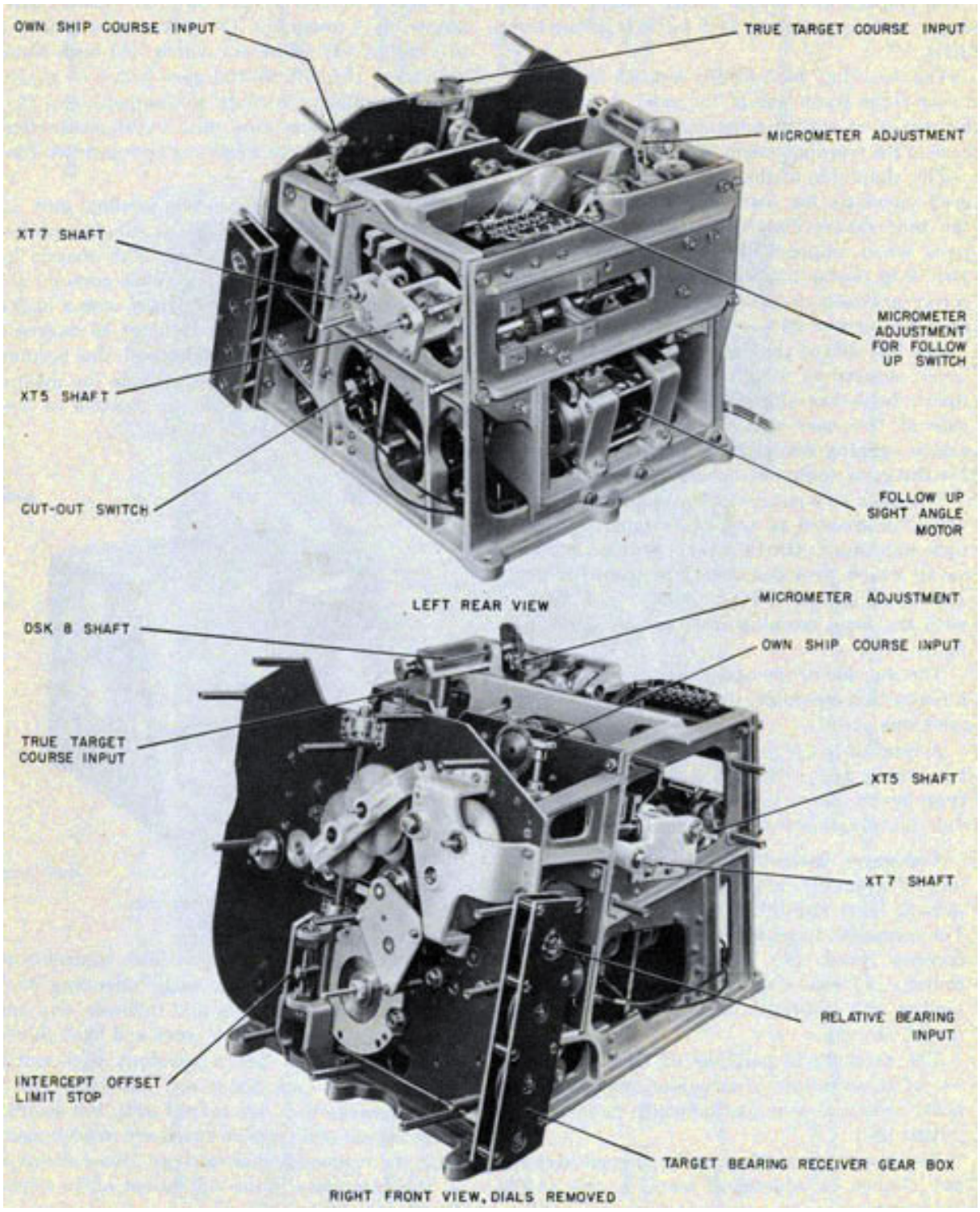

Figure 31-Front and rear views of computer assembly.

The vector gear in the front solver and the vector gear in the back solver have a straight slot passing through their centers. The vector gear of the front solver, by means of its input gear, is positioned by target angle which is derived from own ship course, relative bearing and target course. The vector gear of the back solver, through its input gear, is positioned by basic sight angle. Therefore, the angle that the center line of the vector gear slots make with the vertical center line of the solver represent (1) target angle and (2) sight angle. See figures 10 and 33.

The pins are joined to blocks which also carry the cam followers. The followers are offset slightly from the pins so that the pins are over the center of the cams, when the followers are near the inner ends of the cam grooves. See figure 33.

The followers ride in the cam grooves and the pins protrude through the slots in the vector gears, so that the pins are moved by both cams and the vector gears, radially by the cams and angularly by the vector gears.

The two racks are pushed back and forth along their guides by the pins. This movement rotates the two output gears which deliver the solved components to other mechanisms in the director via differential DF-6.

For a complete description on component solvers, see OP 1140, Basic Fire Control Mechanisms.

SIGHT ANGLE (FOLLOW-UP) MOTOR. This reversible motor is of the induction-capacitor type. The rotor is not connected directly to the power supply but has current induced in it by the action of a magnetic field produced by the stator coils when 115-volt A. C. is supplied to

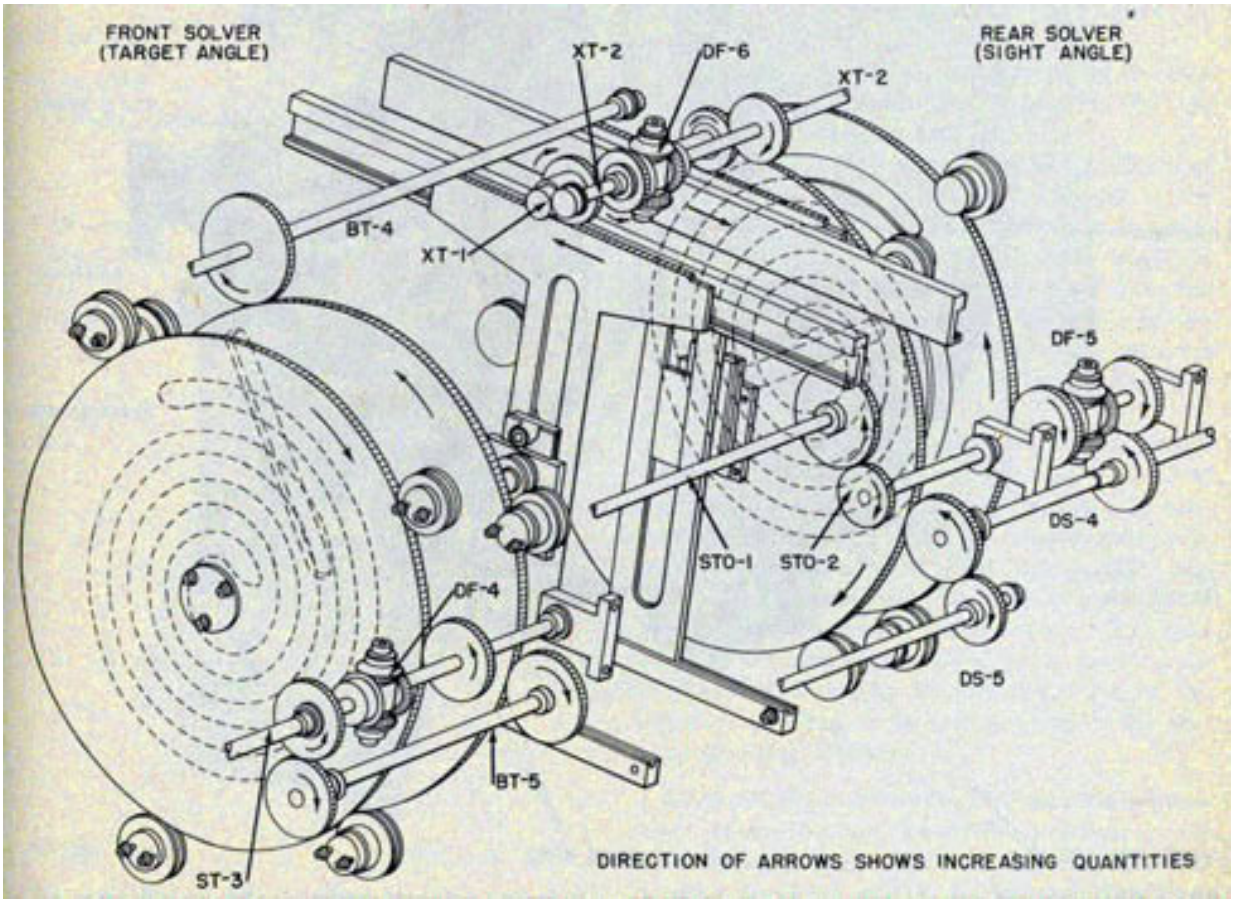

Figure 32-Diagram of angle solver assembly.

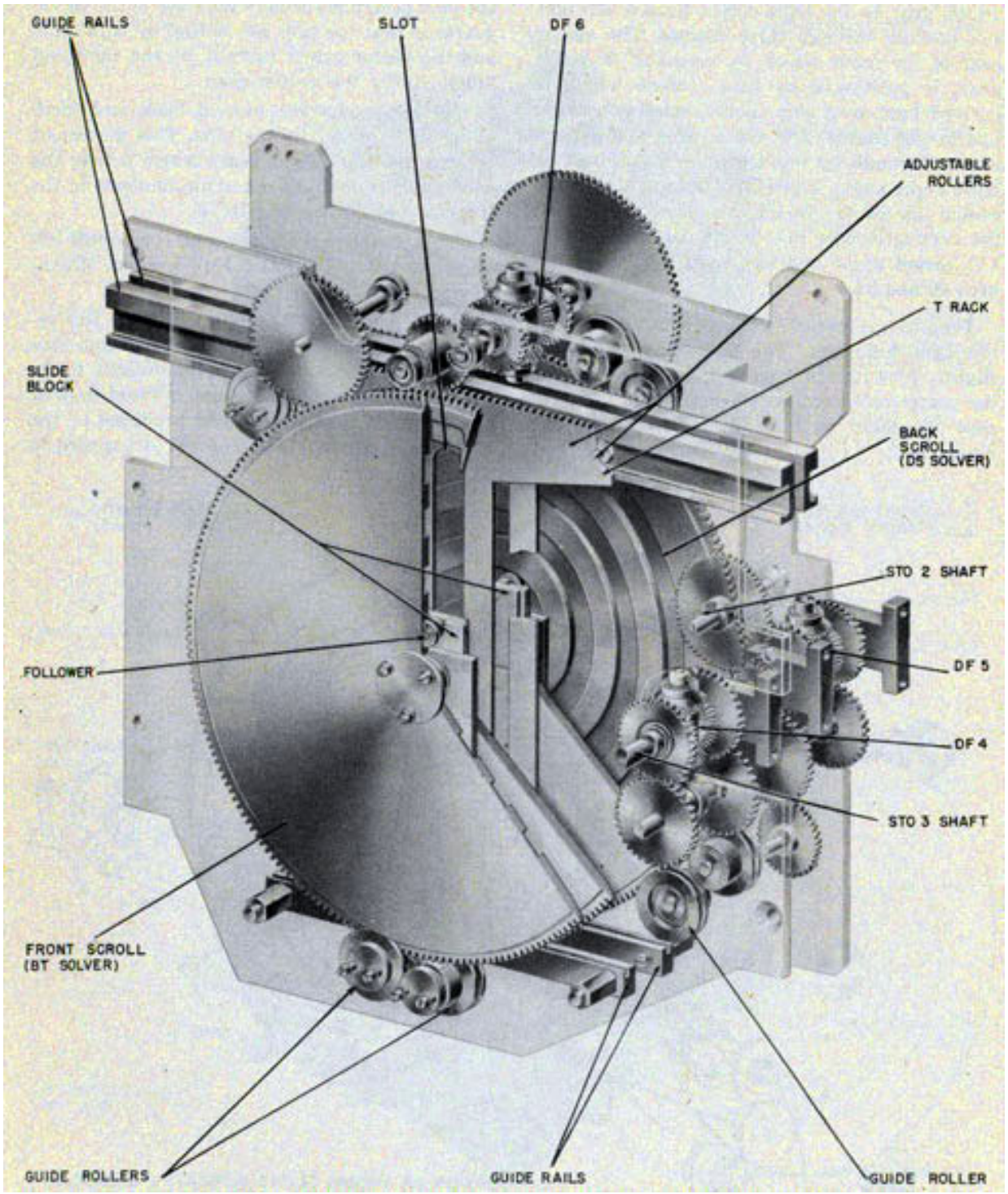

Figure 33-Cutaway view of angle solver assembly showing gearing and shafting between front and back scrolls.

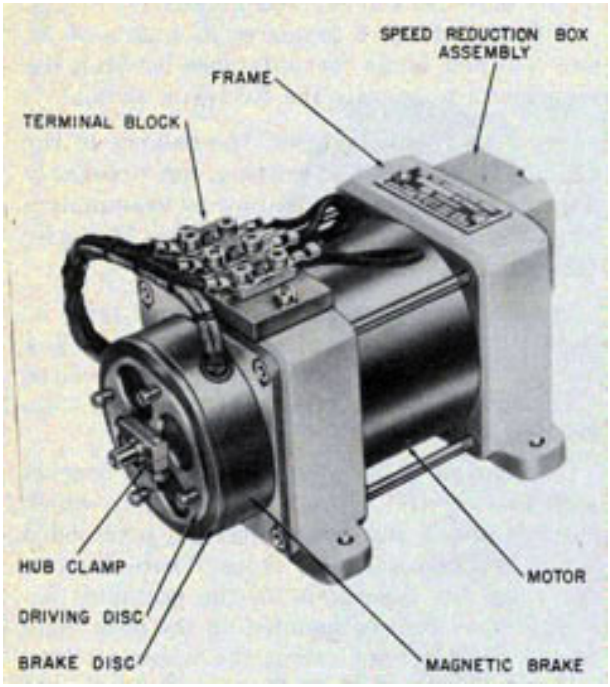

Figure 34-Sight angle (follow-up) motor.

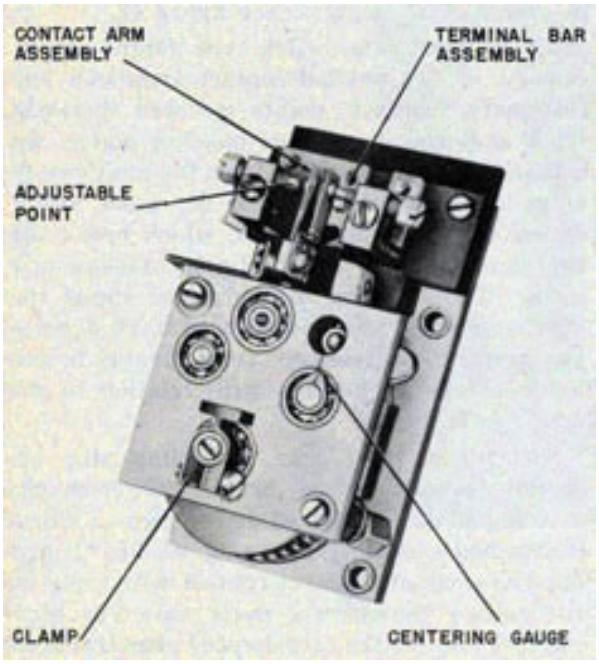

Figure 35-The follow-up switch controls direction of motor rotation.

the coils. The motor's principal function is to drive the vector gear of the back solver assembly and the telescope. The motor drives the back solver, producing target deflection (Xt) until it equals torpedo deflection (Xto). When these two quantities are equal the correct sight angle to solve the torpedo control problem is produced and the servo motor stops. This sight angle positions the telescope in relation to the rotating case, through an angle equal to the sight angle. See figures 34 and 40.

In case of casualty to the ship's electrical power causing the sight angle motor to become inoperative, the sight angle hand crank can be engaged to take over the sight angle drive. Rotation of this crank also positions the vector gear of the back solver and the telescope.

FOLLOW-UP SWITCH. This switch controls the power supply to the sight angle motor causing it to rotate in either direction. See figures 35 and 36.

This follow-up switch is operated by the output of the differential DF-6, that is, by the difference between Xt and Xto.

When Xt is greater than Xto, the contacts of the follow-up switch are closed, energizing the sight angle motor so that it rotates in a direction that will drive the vector gear until Xt equals Xto. When Xt is smaller than Xto, the contacts are closed to operate the motor in the opposite direction so that the vector gear is driven to increase Xt until it equals Xto. See figure 10.

The output of DF-6 sent to the follow-up switch, operates an intermittent gear drive of this unit. A segment attached to the intermittent gears moves a mutated pinion gear connected on a shaft with the signal cam. See figure 36. The rotation of the pear shaped signal cam raises and lowers a cam follower and contact block which is connected to the center contact arm and causes the arm to move to the right or left and form a contact with the stationary outer contacts.

BACK PLATE ASSEMBLY. The cast aluminum alloy frame of this assembly contains in its base the sight angle follow-up motor. Extended interior brackets, above the base, provide support and bearing for the back plate gear train,

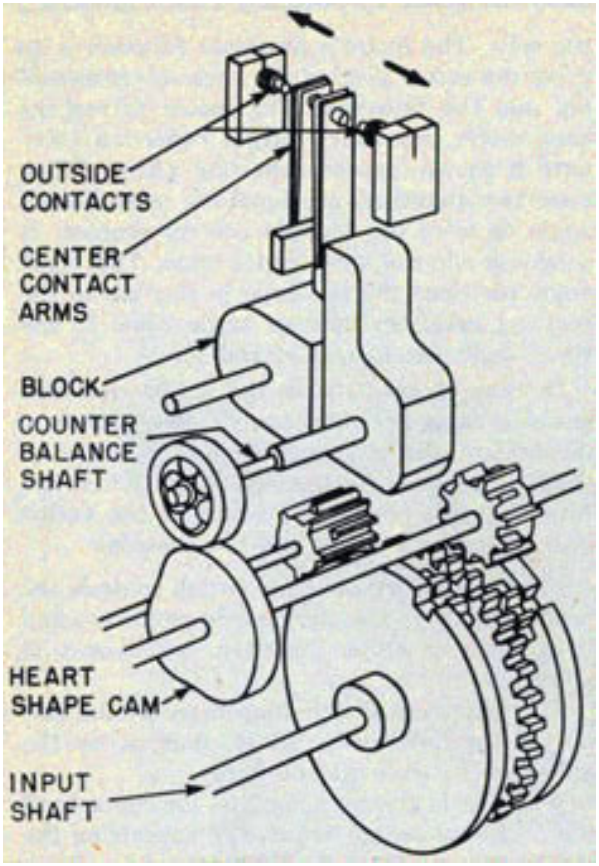

Figure 36-Operatng diagram of follow-up switch.

driven by the sight angle motor, that furnishes motion to the telescope pivot gears and the gears of the back solver assembly. See figures 37 and 40.

DIFFERENTIAL GEAR Box. The differential gear box assembly consists of three bevel-gear type differentials: DF-1, DF-2, and DF-3, which are supported between the top and bottom plates of the differential gear box. See figure 39.

Differential DF-4 is the compensating differential follower constant for any given speed regardless of the movement of the vector gear.

Differential DF-6 compares its inputs of Xt and Xto and sends the difference between the two inputs to operate the follow-up switch.

SHAFTING AND GEARING. The balance of the computer shafting and gearing, not previously described, can best be explained by examination of the gearing diagram. See figure 148: Also refer to figures 33, 38, 39, and 40.

STOP MECHANISMS. There are three types of stops in the computer assembly: (1) traveling nut or screw type, (2) contact-arm switch type, and (3) intermittent gear type limit stop. See figures 38 and 41.

The traveling nut stop consists of a bracket with two vertical posts, a traveling nut, which extends into a slot in the bracket, a threaded screw and two adjusting stops. There are two traveling nut type stops in the computer assembly. One stop is mounted on the back plate of the computer and stops the telescope from training in excess of 70 degrees in relation to the rotating case and the other traveling nut stop is on the front plate and stops the inner dial of the intercept offset group from turning in excess of 25 degrees. See figure 42.

The contact arm switch type (sight angle) consists of two povited contact arms and two stationary contact points secured between front and back reinforced

for the front solver. It receives and sends target speed to the spiral cam and maintains the radial displacement of the cam follower constant for any given speed regardless of the movement of the vector gear.

Differential DF-5 is the compensating differential for the back solver. It receives and sends torpedo speed to the spiral cam and maintains the radial displacement of the cam

bakelite plates. An actuating pin protruding from the limit switch actuating gear revolves and depresses either of the pivoted contact arms, which break the electrical circuit to the sight angle (follow-up) motor. The stopping of the motor limits the sight angle that can be produced to 70 degrees and prevents the telescope from turning in azimuth beyond 70 degrees with relation to the case. See figure 40.

The intermittent gear type limit stop assembly consists of a bronze flower-shaped driven gear and a toothed driver gear to which is attached a small stop. See figures 38, 41, and 62. The small stop makes contact with a pin on the inside of the assembly cover plate. The intermittent stop for the target speed gear train has a one-tooth drive gear. This stop is used to prevent the cam follower, in the spiral groove of

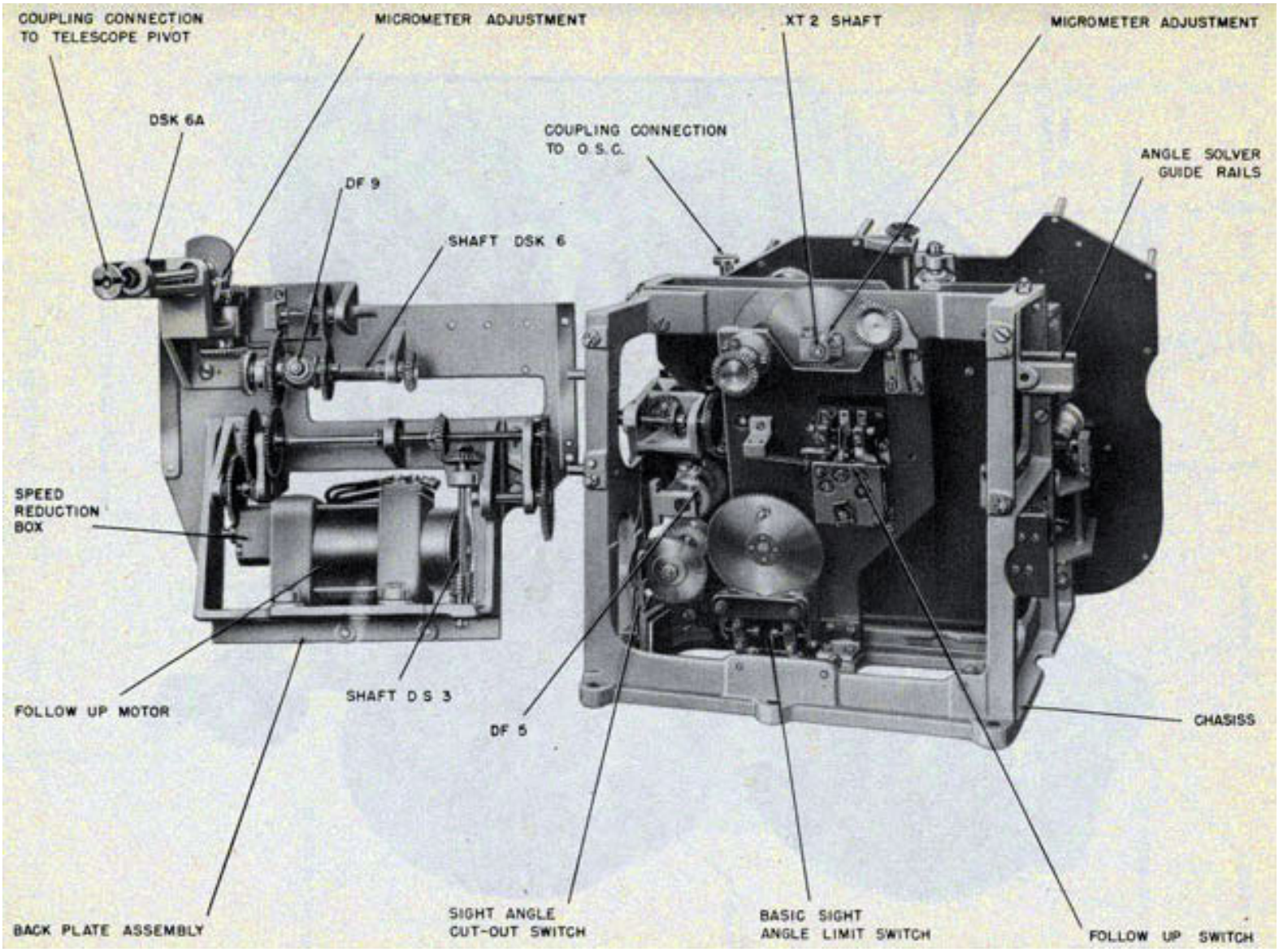

Figure 37-Back plate removed from computer assembly.

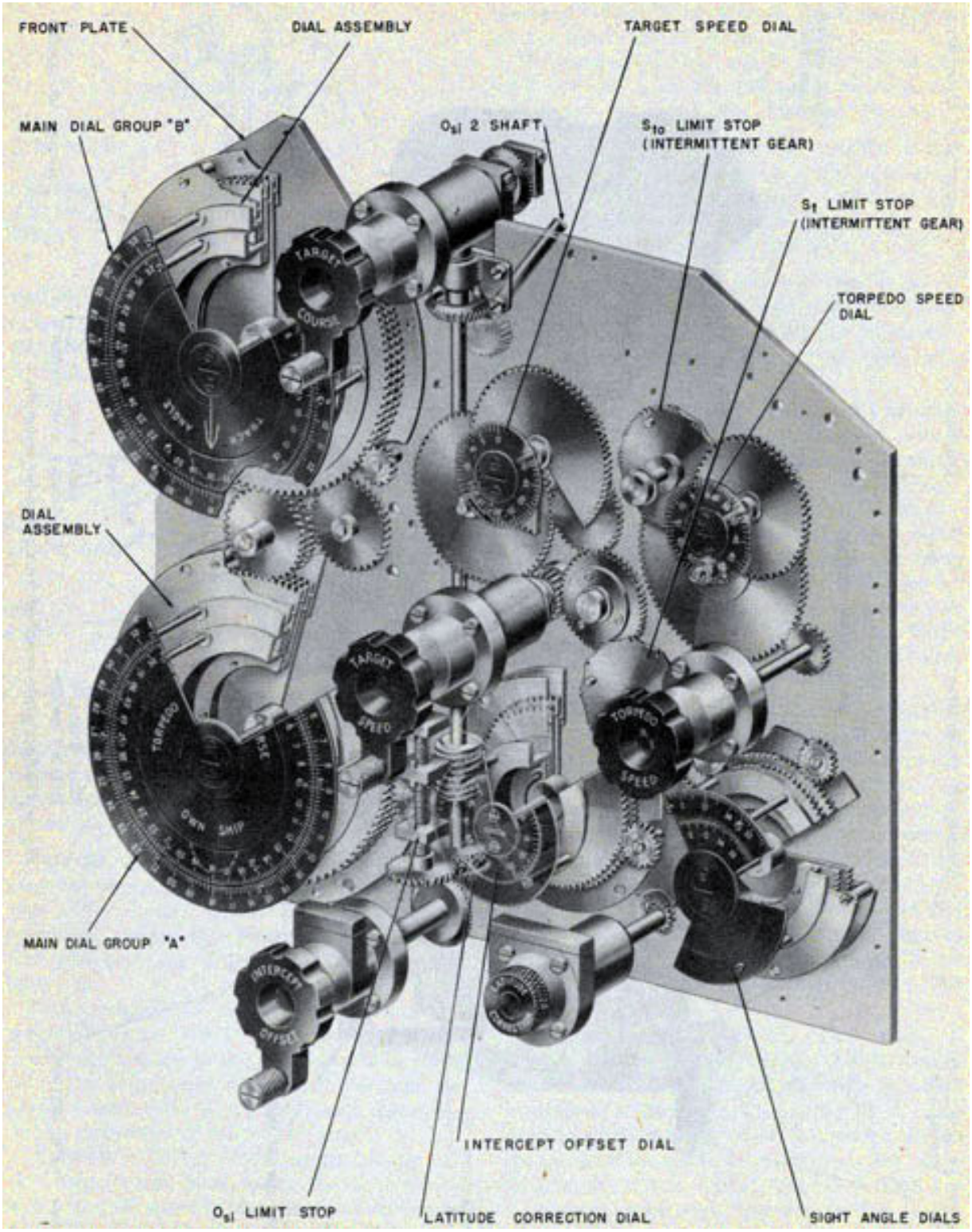

Figure 38-Cutaway of dials, gearing and computer front plate.

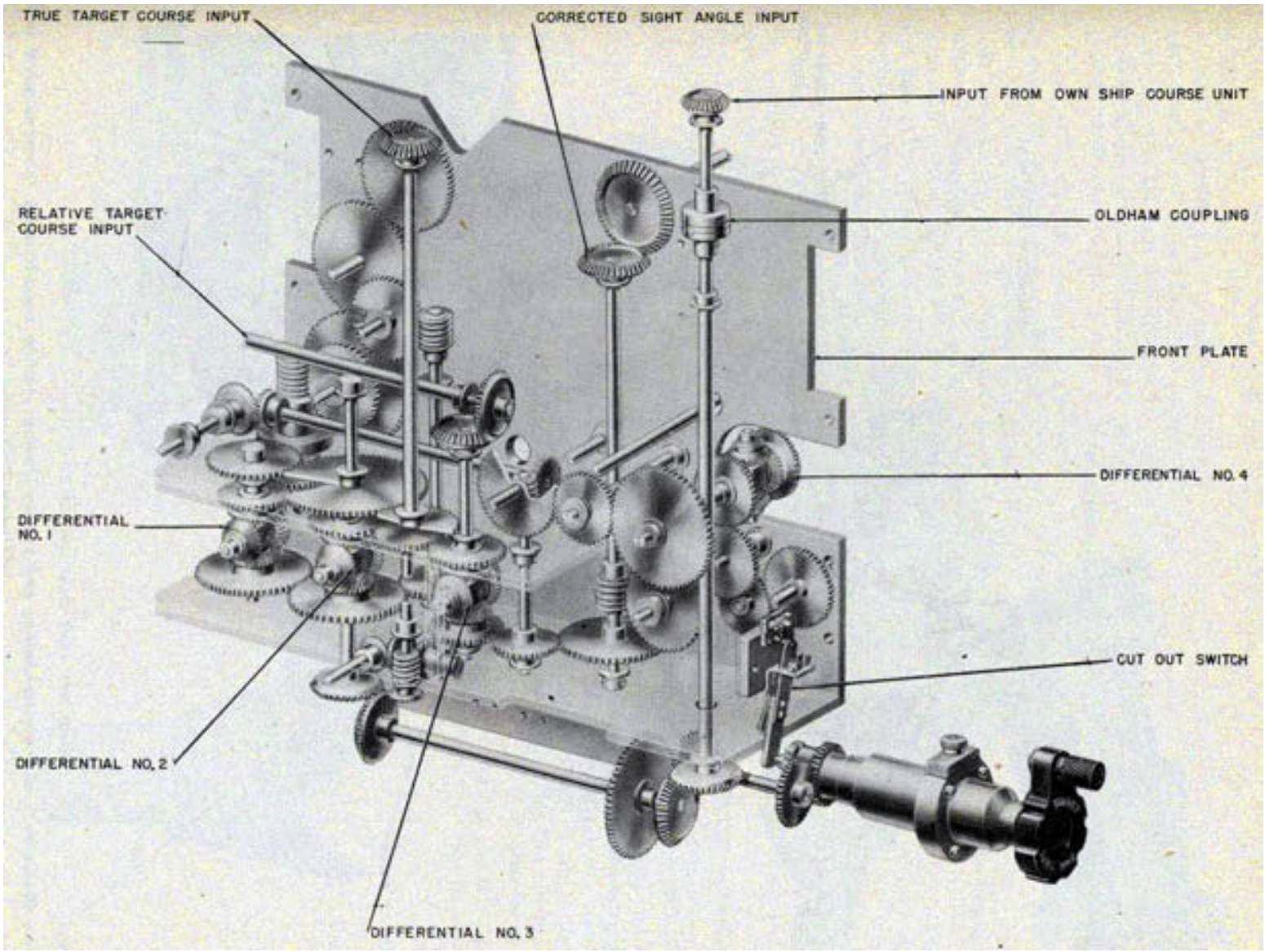

Figure 39-Cutaway of computer showing differential gear assemblies.

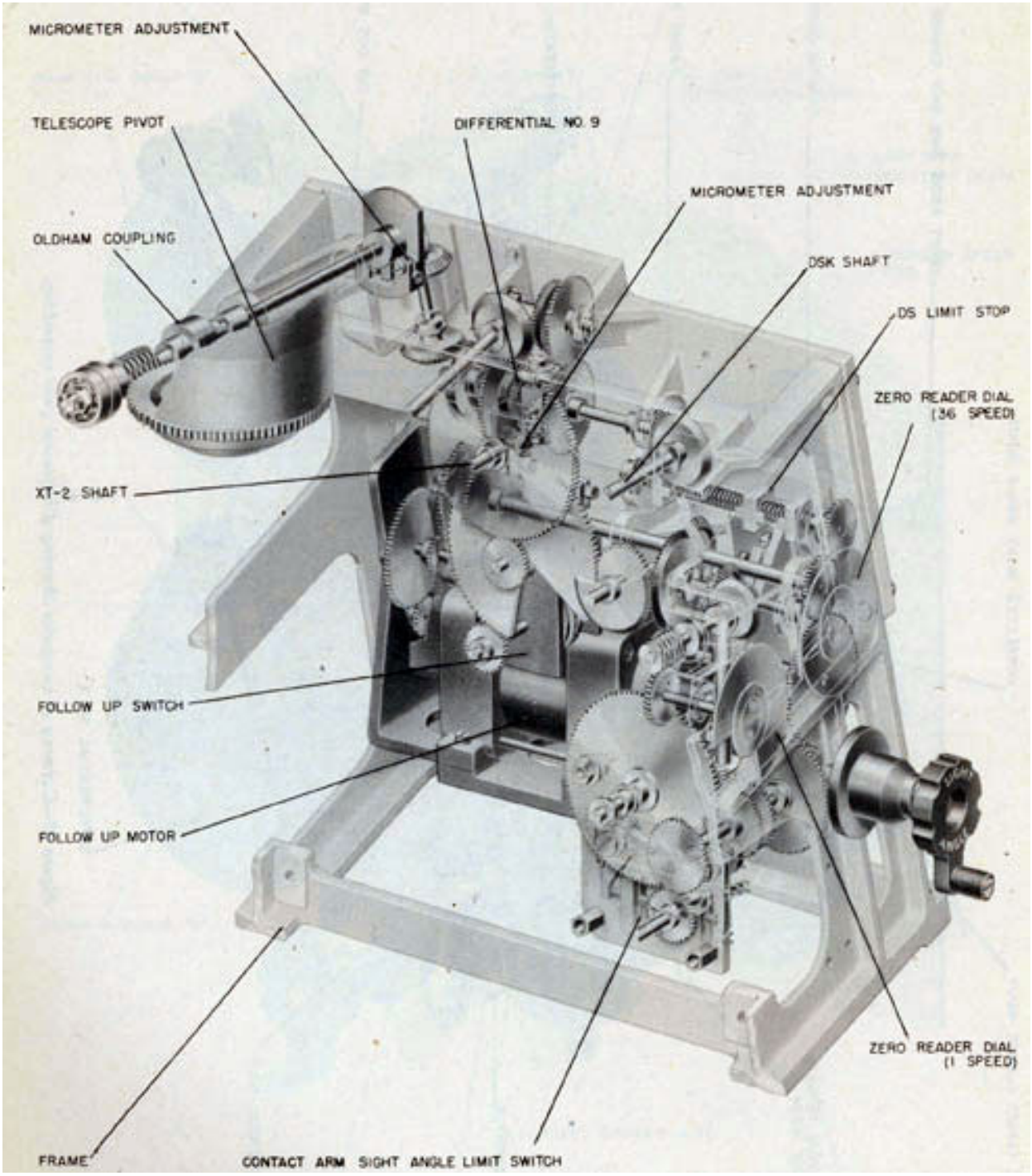

Figure 40-Cutaway of computer shafting and gearing showing shafting connection to telescope pivot and sight angle limit switch.

the back solver, from jamming at either end of the groove.

The intermittent stop for the torpedo speed gear train has a three-tooth drive gear. This stop prevents the cam follower, in the spiral groove of the front solver, from jamming at either end of the groove.

HEATING UNIT. This unit is located in the rear of the computer assembly on the lower left side. The unit is composed of resistance wire wound around an inverted porcelain cone. When installed the resistance ought to be approximately 70 ohms on 115 volts current is 1.6 amps. The heater is Used to warm Up the mechanism of the torpedo director in extremely cold weather. See figure 43.

Own Ship Course Assembly. This assembly is located in the upper right hand corner of the rotating case and is secured to the top of the case. The assembly consists of a rectangular frame open at the back and top, a dial shield and bracket containing the one-speed own ship

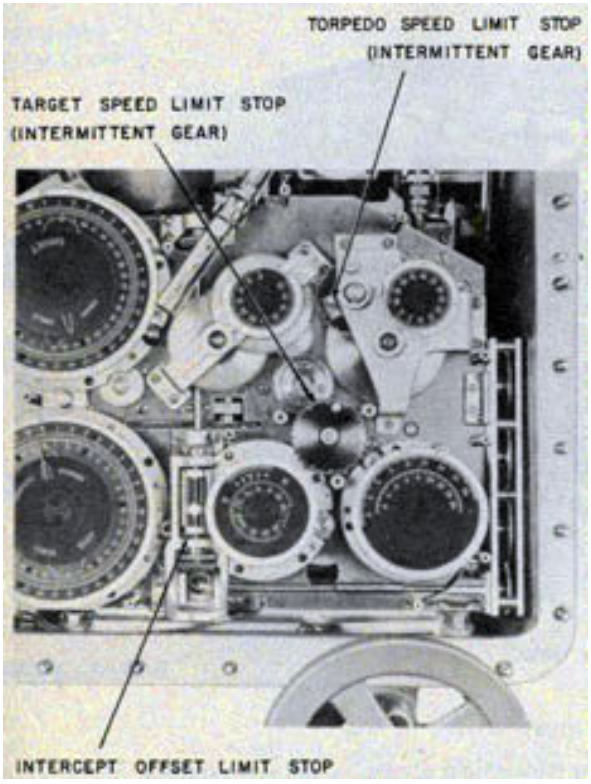

Figure 41-View of director limit stop mechanisms.

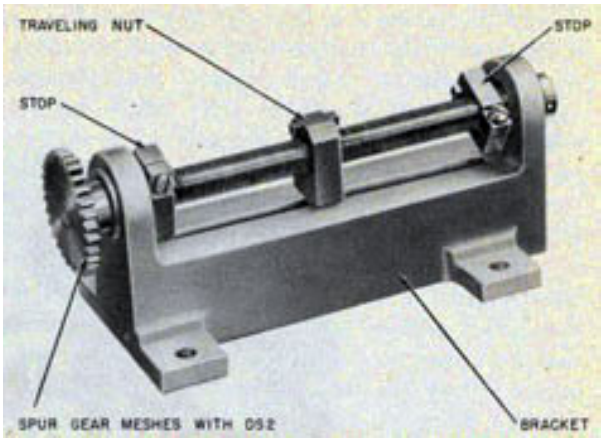

Figure 42-Traveling nut type of limit stop.

Course and zero reader dials, the type 5B synchro motor with a heart-shaped cam follow-up switch assembly and a 115-volt a-c servo motor complete with damper and reduction gear. See figures 44 and 46.

For a complete description on operation and function of a synchro motor and follow-up unit. see OP 1140, Basic Fire Control Mechanisms.

The own ship course unit receives continuous own ship course signals, electrically, from the gyro compass system and converts them into a mechanical output which is transmitted by means of a coupled shaft to the computer assembly.

In case of power failure to the servo motor. own ship course can be fed into the own ship

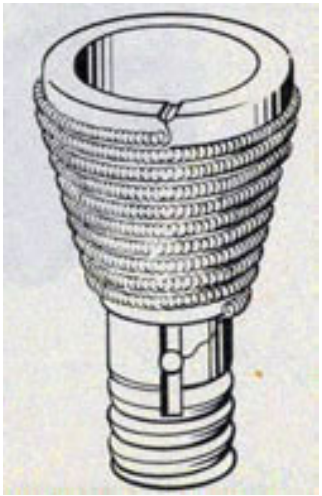
Figure 43-Heating unit.

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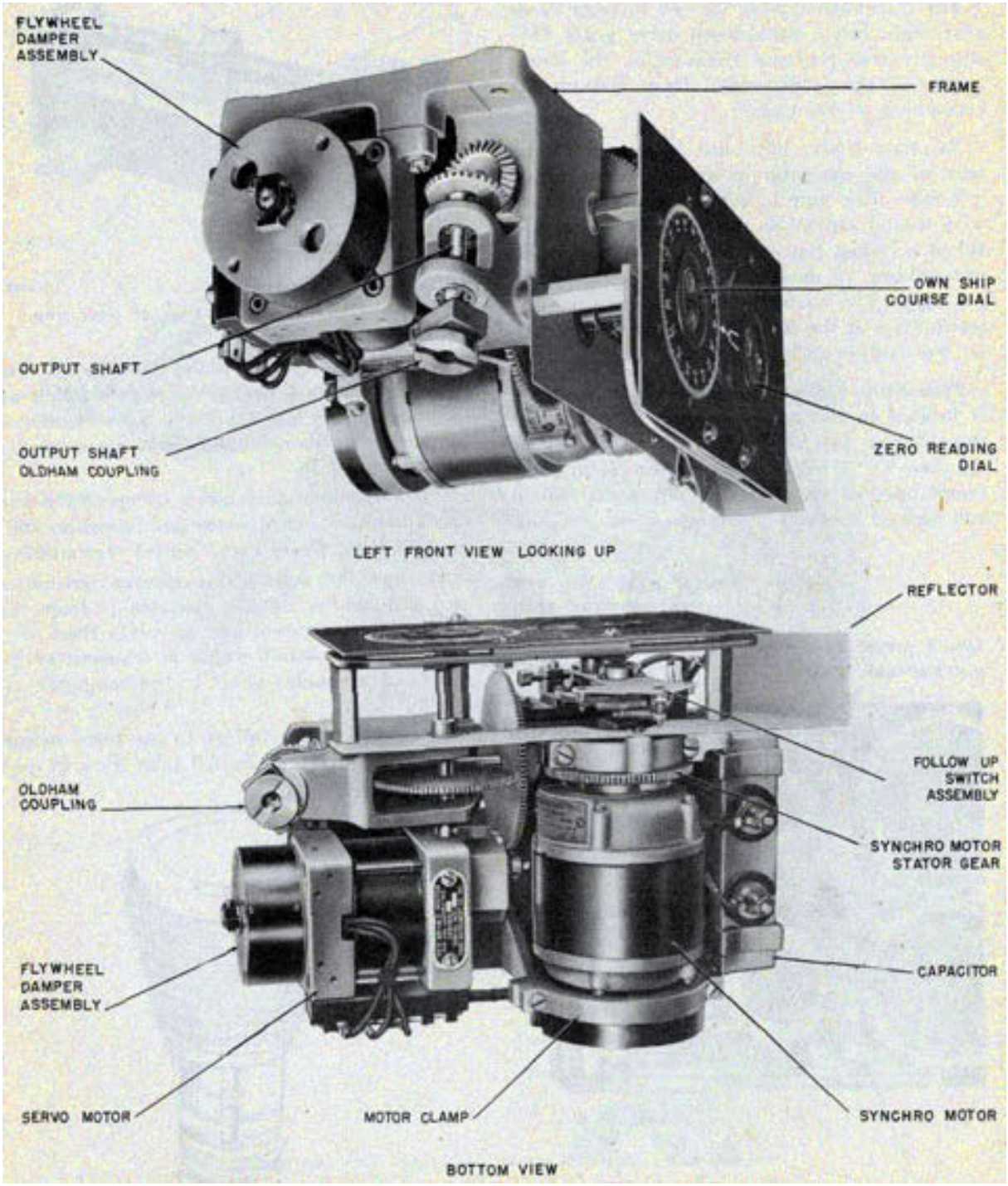

Figure 44-Own ship course assembly showing relationship of synchro and servo motors.

course unit by the use of the hand crank on the right side of the rotating case.

SYNCHRO MOTOR TYPE 5B. This motor consists of a stator, rotor, case, inertia damper, two bearing caps, and brushes. In addition, a heart-shaped cam follow-up switch assembly is ball-bearing mounted on the rotor shaft. The one-speed zero reader dial is attached to the rotor shaft of the synchro motor. The main purpose of this dial is to show when the own ship course signal, received by the synchro motor has been executed. When the synchro motor receives a signal, the dial is displaced from its zero position. As the signal is executed, the zero reader dial is restored to its original zero position, that is, the index of the dial is lined up with the fixed index of the dial plate.

The synchro motor receives own ship course signals, electrically from the gyro compass system. These signals displace the rotor. As the rotor turns it displaces the heart-shaped follow-up switch from its zero position and causes an electrical contact to close and energize, via a capacitor, the servo motor.

Although synchro motors transmit extremely accurate signals, their outputs must be boosted considerably before they can drive heavily loaded shafts. The reason is that the torque delivered by synchro falls off sharply as the rotor approaches the point of synchronism. As the rotor nears the point of zero error, the induced current in the stator coils is rapidly reduced, seriously affecting the ability of the synchro motor to drive a heavy load. At the point of zero error, torque becomes zero. Accordingly, the synchro motor is used as a control for the servo motor that drives the actual shaft load to the computer assembly. For a complete description of synchro motors, see op. 1303, United States Navy Synchros.

The heart-shaped cam follow-up switch assembly consists of a follower arm, follower roller and spring, and a heart-shaped cam. The spring keeps the follower roller seated firmly in the valley of the heart-shaped cam. See figure 45. The cam functions when a signal causes the rotor of the synchro motor to turn while the power to the servo motor is shut off. In this case, the synchro motor would turn, rotating

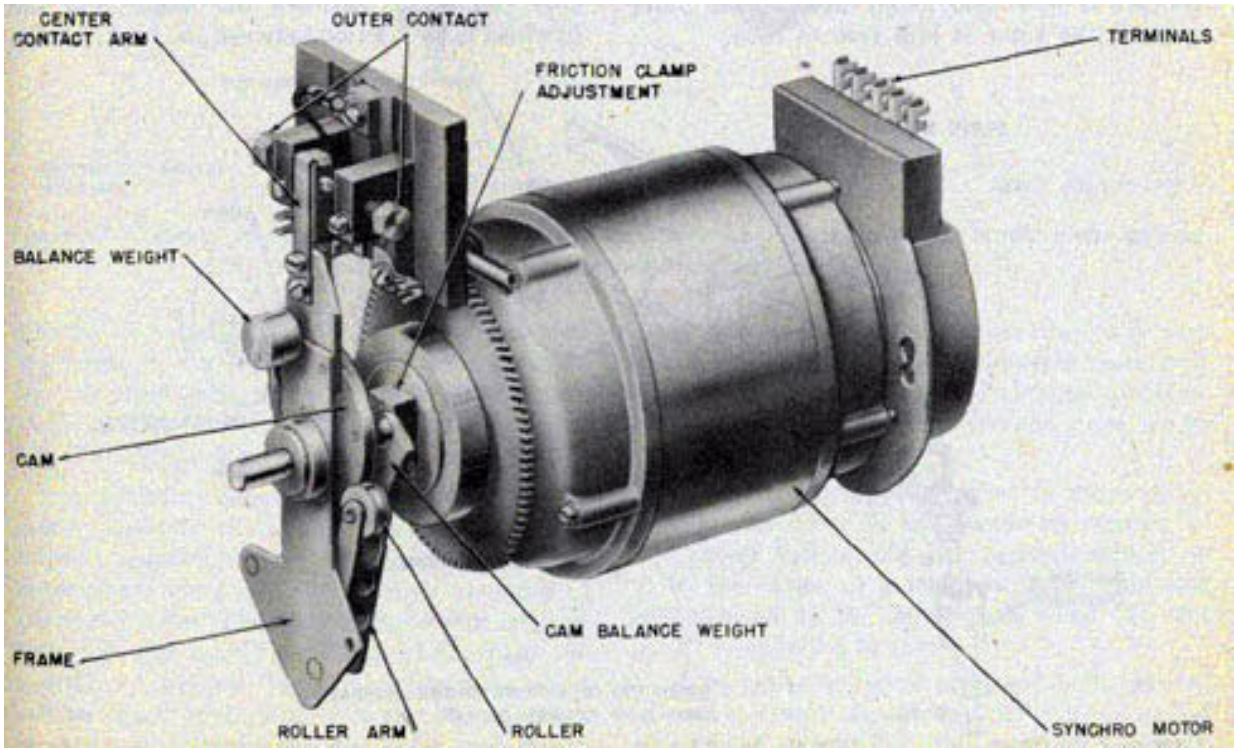

Figure 45-View of own ship course assembly synchro motor and follow-up switch showing friction adjustment.

the center contact arm against the outer contact arm. To prevent possible damage to the contacts, the arm carrying the center contacts is not attached directly to the rotor shaft, but is fixed to the heart-shaped cam. This cam is ball-bearing mounted on the rotor shaft so that it can turn freely.

Whenever the rotor is turned by an incoming signal, the follower arm must turn because it is keyed to the rotor shaft. As the follower arm turns, the follower roller is pulled around. The roller being firmly seated in the valley of the heart-shaped cam, pulls the cam around with the roller. When the cam is rotated, the center contact is brought against the outer contact and the servo motor starts to drive.

As the signal continues to come in from the gyro compass system faster than the servo can drive, the rotor of the synchro motor continues to turn and carry the follower-arm around with it. The follower roller is now forced up and out of the valley, and rides around the heart-shaped cam pressed to the cam by the action of the spring. So, although the center contact is now held firmly against the outer contact, the rotor is still free to turn.

Now the rotor can turn until the follower roller reaches the peak of the cam without disturbing the contacts. This means that if the servo power is shut off, a considerable input can be transmitted to the synchro motor without throwing the system out of synchronism.

When the stator of the synchro motor is rotated, the rotor is turned back toward the position from which it started, and the follower roller becomes again seated firmly in the valley of the cam through the action of the follower spring. The contacts are not yet separated so the servo motor keeps driving the stator around. As the rotor is turned still farther, the heart-shaped cam is moved around by the follower aim. The contacts separate and the servo motor ceases to drive. See figures 36 and 45.

The inertia damper assembly, -consisting of -flywheel (friction drum), brake blocks and adjusting screws, is ball-bearing mounted on the end of the synchro motor rotor shaft. See figure 47. The inertia damper is attached to the synchro motor to prevent hunting or oscillation as the matched or zero position is reached. The only connection between the motor and the flywheel is by friction between the brake blocks

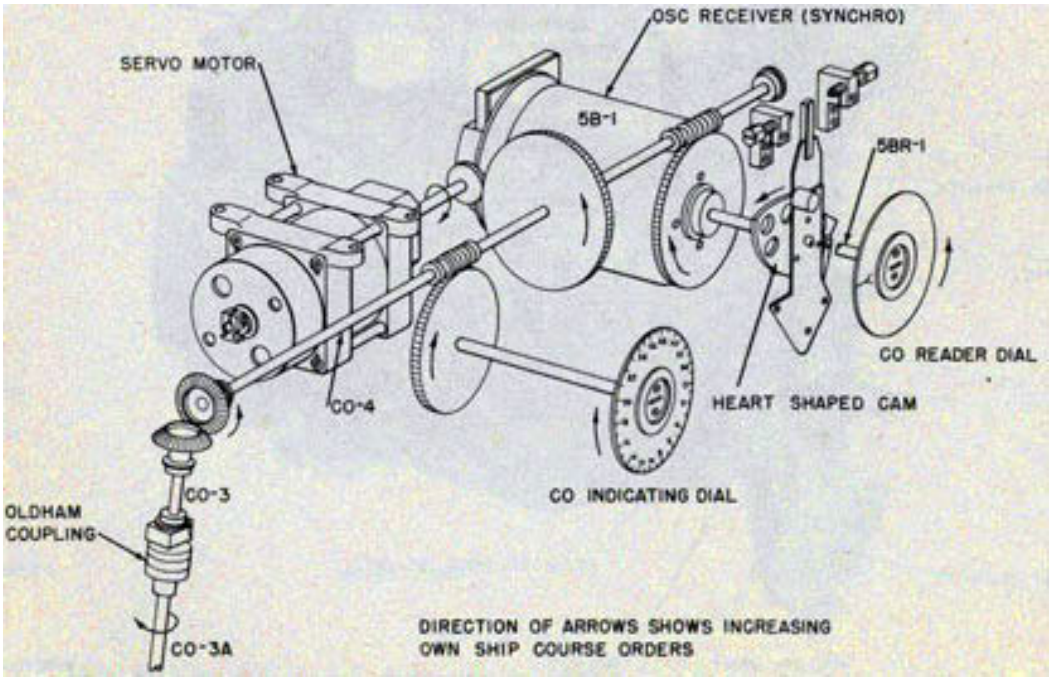

Figure 46-Diagram of own ship course assembly shafting and gearing.

DESCRIPTION-DIRECTOR

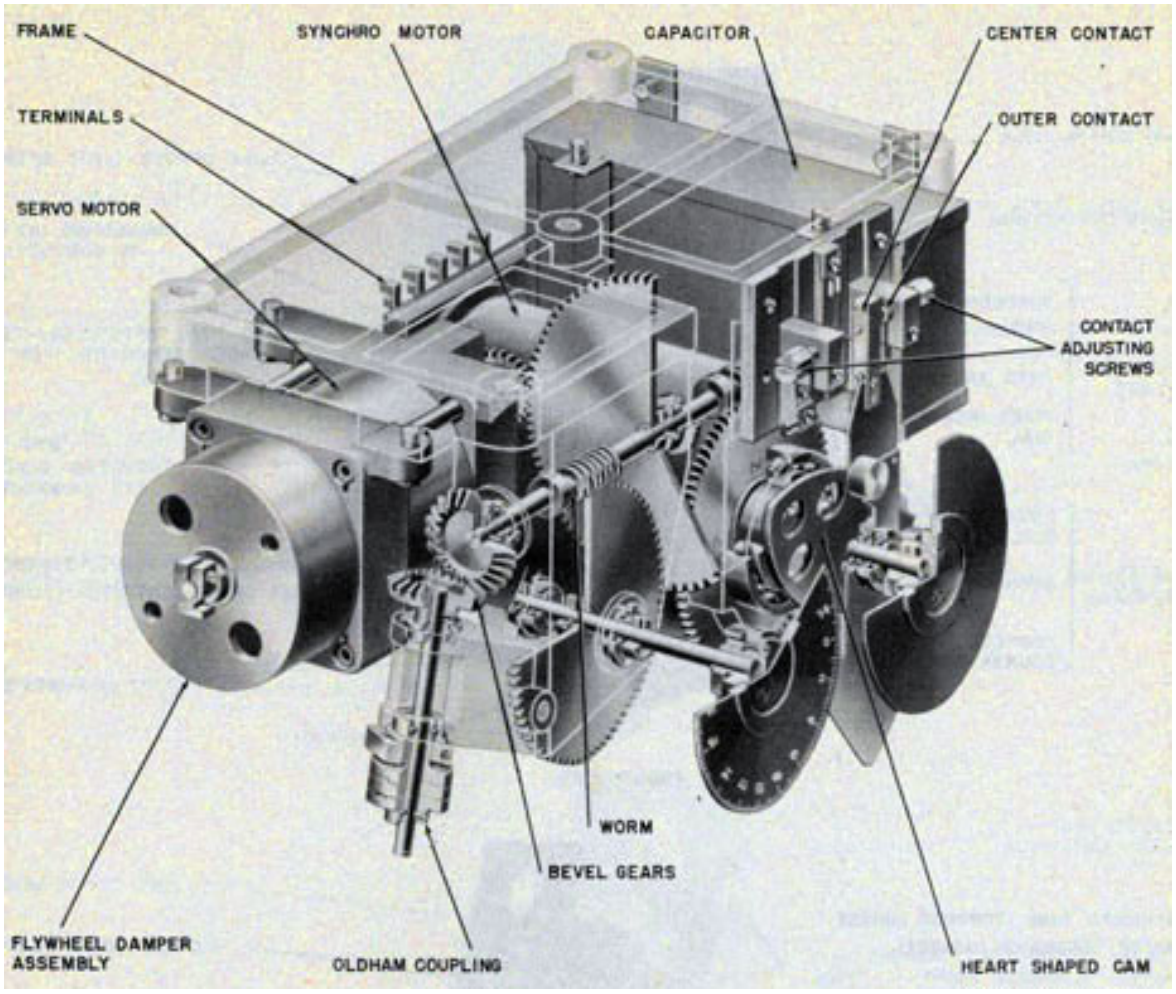

Figure 47-Cutaway of own ship course assembly showing heart-shaped corn, follow-up switch, dials gearing servo motor and capacitor.

and the friction drum. As the motor tends to accelerate or decelerate, part of the inertia of the flywheel will attempt to prevent speed changes. The friction may be adjusted by turning the adjusting screws.

The 1/200 hp capacitor induction type servo motor consists of a rotor. stator, two end frames, capacitor, and inertia damper. The rotor shaft runs in ball bearings mounted in the end frames. The ends of the stator shell fit into the end frames and four bolts hold the assembly together. One end of the rotor shaft carries the inertia damper, while the capacitor is attached to the frame of the own ship course unit. See figure 47. The servo motor takes the own ship course signals from the own ship course synchro motor and converts them into mechanical motion powerful enough to drive, through a reduction gear, the computer mechanism.

The servo motor is of the induction type, that is, the rotor is not connected directly to the power supply, but has current induced in it by the action of a magnetic field. This field is produced by the stator coils when 115 volt A. C. is supplied to them.

If no capacitor were used and both coils of the servo stator were connected directly across the power supply line, the rotor of the servo motor would not revolve but would merely

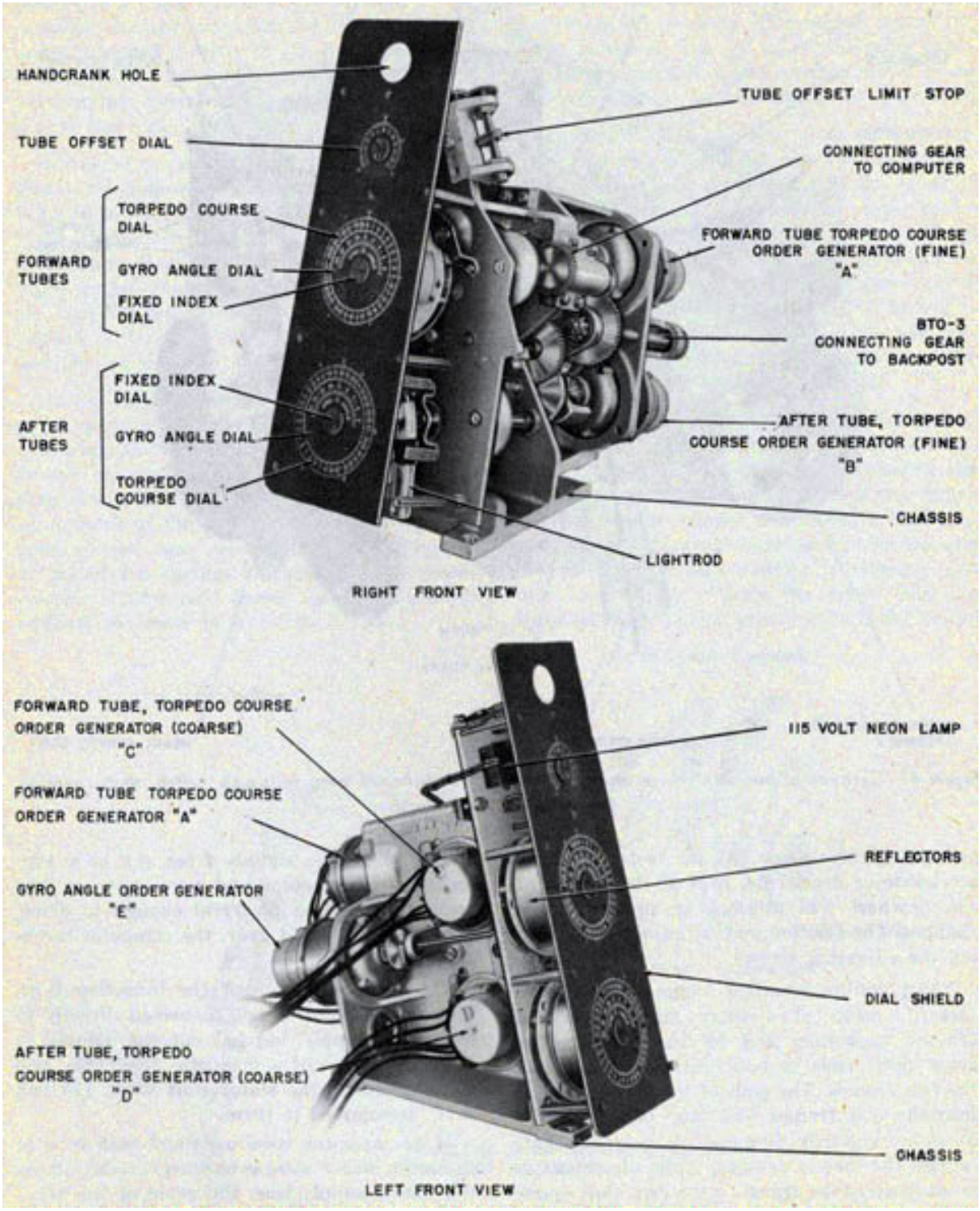

Figure 48-Right front and left front views of transmitter.

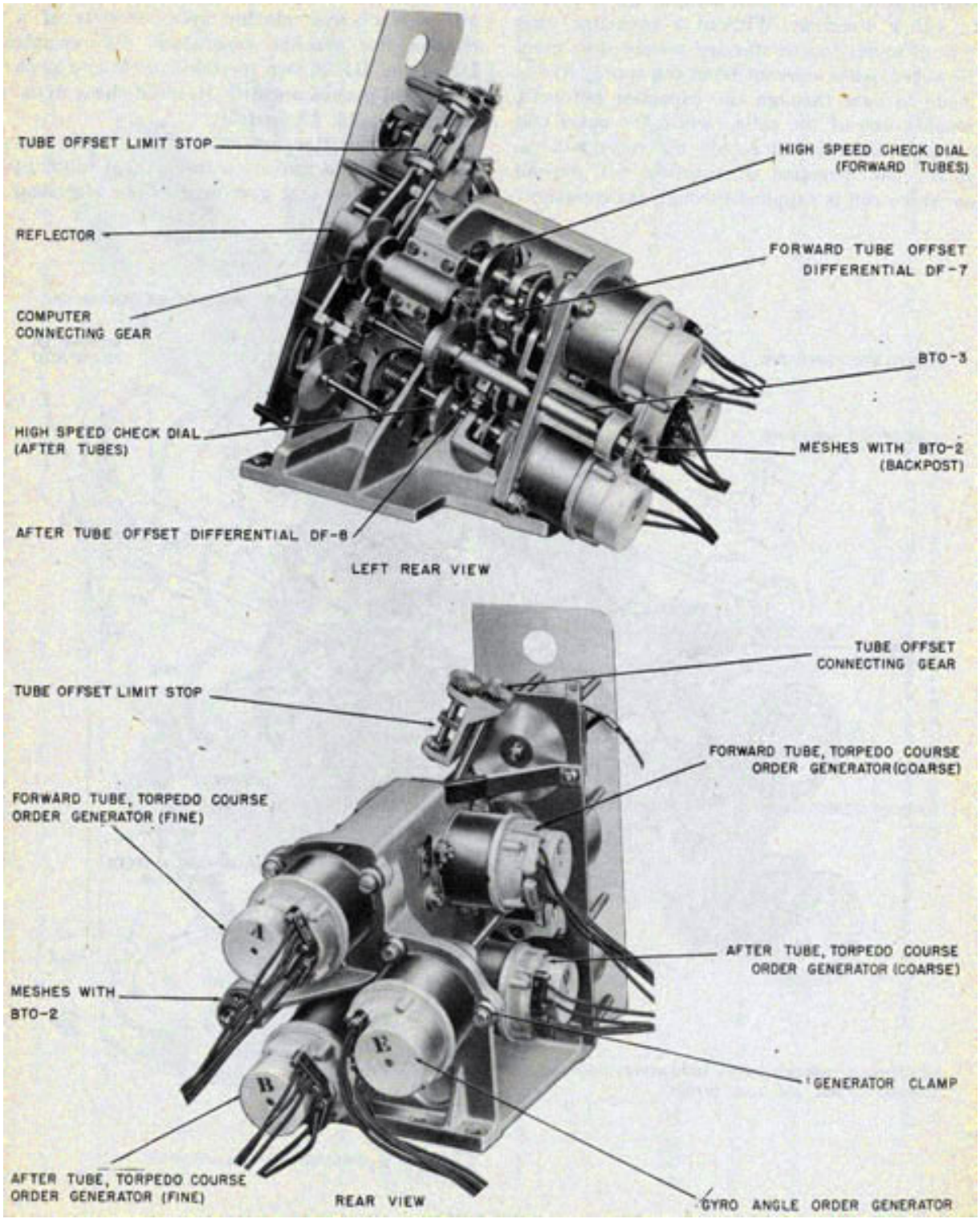

Figure 49-Left rear and right rear views of transmitter.

remain stationary, unless actually given a push in either direction. Without a capacitor, this type of motor has no starting torque of its own. However, when current from the supply line is made to pass through the capacitor before it reaches one of the coils (while the outer coil remains directly connected) the rotor will revolve. The direction of rotation will depend on which coil is supplied through the capacitor.

Transmitter Unit. This unit, located along the left side of the rotating case, consists of a chassis, five synchro generators, differentials DF-7 and DF-8, two torpedo course and gyro angle dial groups and two 36-speed check dials. See figures 48, 49, and 50.

The transmitter assembly, as its name implies is used to convert a mechanical input of torpedo course and gyro angle into electrical

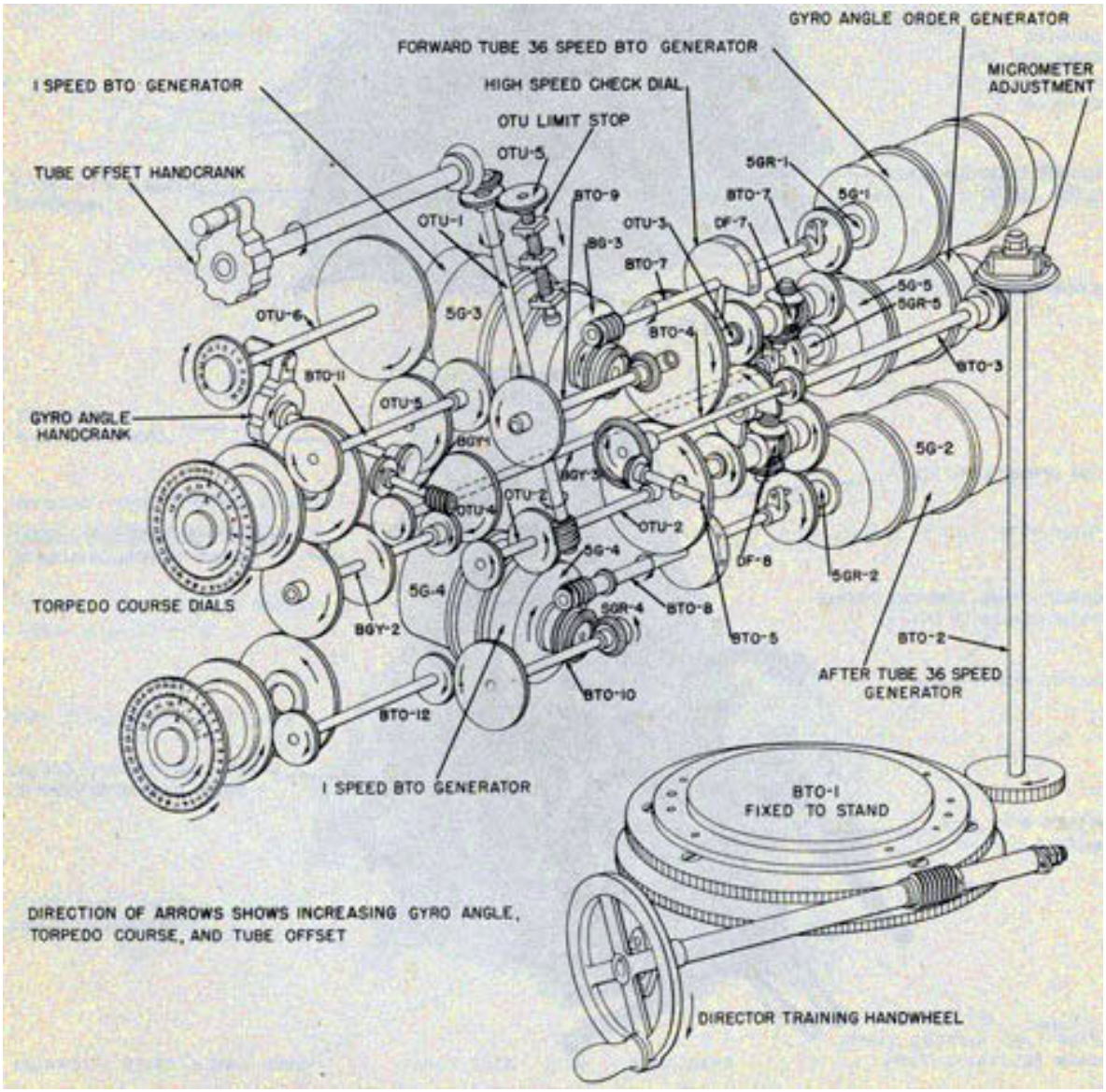

Figure 50-Diagram of transmitter shafting, gearing and synchro generators.

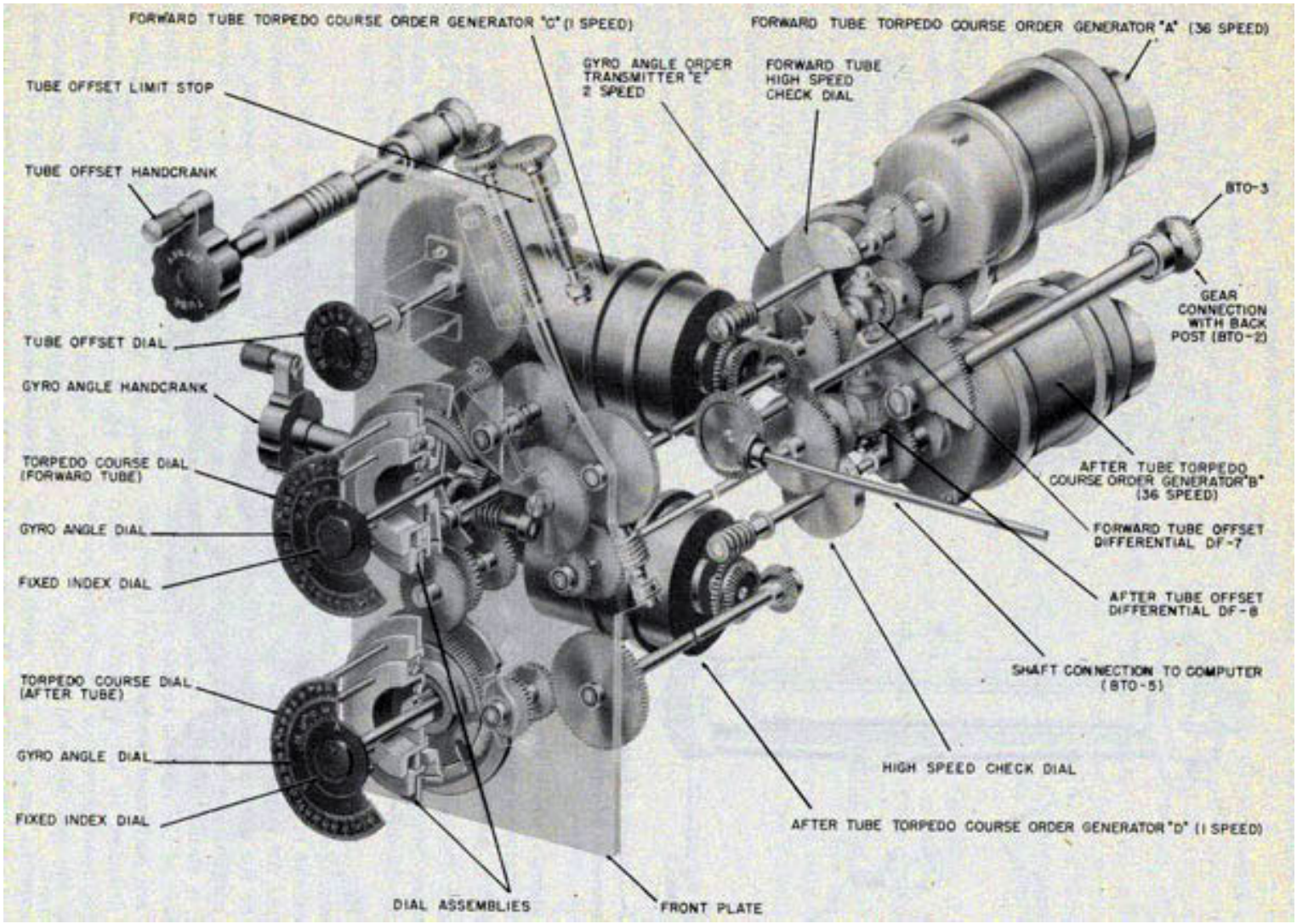

Figure 51-Cutaway of transmitter showing gear connection to back post (BTO-2 shaft). The transmitter unit drives through the back post to rotate the case on the director stand.

description of synchro generators; see OP 1303, United States Navy Synchros.

CHECK DIALS. One 36-speed check dial is located on the rotor shafting of each of the 36speed synchro generators. See figure 51. These dials are graduated every 10 minutes and numbered every degree from 0 to 10, thus one revolution of the dial represents 10 degrees. The dials are used mainly for test and adjustment purposes. To read these dials, the gyro angle cover on the left side of the case must be removed.

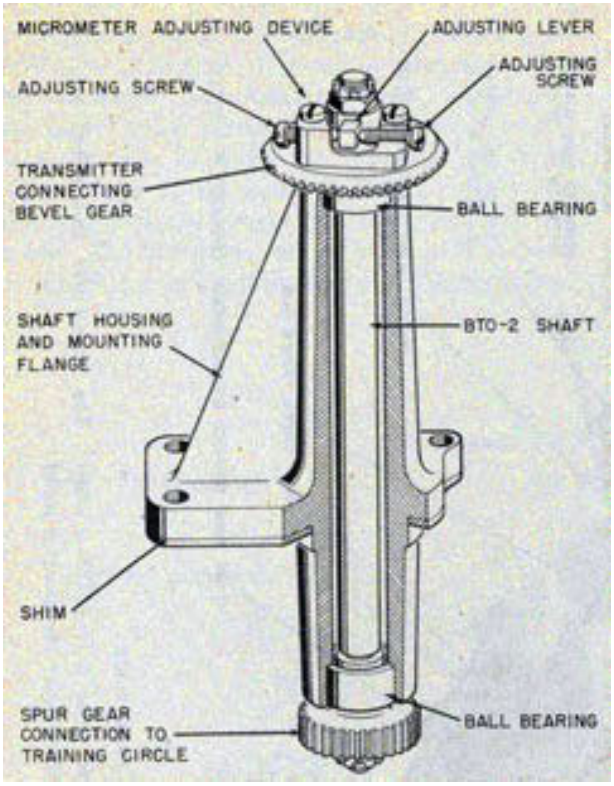

Figure 52-Cutaway of back post (BTO-2 shaft) showing micrometer adjustment and connecting gear.

output signals which are sent to the torpedo course indicators at the fore and after torpedo tube mounts. See figure 146.

CHASSIS. The cast aluminum chassis supports the synchro generators, gearing, shafting, the dials, and the differentials.

SYNCHRO GENERATORS. There are five synchro generators, Type 5G, in this assembly. These consist of two sets of one-and 36-speed generators for torpedo course and a two-speed generator for gyro angle. Each of these generators consists of a rotor that is coupled to the gearing, a stator, collector rings and brushes. The rotors of the torpedo course synchro generators are positioned mechanically by torpedo course produced in the computer. The rotor of the two-speed generator is positioned by rotation of the gyro angle hand crank.

The synchro generators are secured to the chassis with generator clamps. For a complete

Back Post (BTO-2 Shaft Assembly). This assembly, extending through the bottom of the case, is connected by means of gearing to the shafting of the transmitter, computer, and training circle assemblies. Examinations of figure 52 shows that the shaft is encased in a circular flanged housing which is attached to the bottom of the director case. Attached to the shaft is an upper micrometer adjustment gear which rests on the felt-sealed ball bearing at the upper end of the vertical housing.

The results of the computer's calculations are relayed via the back post to the transmitter, while at the same time the turning of the lower gear, meshing with the outer gear ring of the training circle, positions the case to the upper sight angle.

Bearing Receivers. There are two general types of bearing receivers used with the torpedo director: (1) the external lighting type and (2) the internal lighting type. See figure 56. The external lighting type, the production model, is described first and the internal lighting type last on pages 54-55.

EXTERNAL LIGHTING TYPE. This bearing receiver consists of a case which houses the chassis that supports the one-and 36-speed synchro motors, one-and 36-speed follow-the-pointer dial group, reduction gearing, shafting and two external lightwells for dial illumination. See figure 53.

The Type 1F synchro motors are secured to the chassis by motor clamps. These motors receive relative target bearing signals electrically at one-and 36-speed, and position the inner dials of the follow-the-pointer dial group. The outer

or ring dials are positioned mechanically by rotation of the training handwheel of the director.

The inner dials of both sets have a center index with 10-minute graduation marks on either side. The one-speed ring dial is graduated every degree and numbered every 10 degrees from 0 to 360. The last zero is omitted from the dial graduations so that a reading of 23 represents 230 degrees. The 36-speed ring dial is graduated every degree from 0 to 10 degrees.

Figures 54 and 55 show the construction of the bearing receiver and how the parts are arranged.

INTERNAL LIGHTING TYPE. This unit was built especially for use with the Torpedo Director Mk 27 Mods 1, 4, and 5 as a stop-gap until the regular production units, previously described, could be supplied in quantity. It was manufactured in two almost identical designs by the Mare Island Naval Shipyard. Torpedo Directors Mark 27 Mods 1, 4, or 5, equipped with either of the two internal lighting type designs, are designated by the mod numbers 7, 8, or 9, respectively. Only the original design will be discussed herein in detail.

This unit is also located on the right front side of the rotating case and operates in the same way as the production unit. See figures 57 and 58 for the original design and BuOrd Sketch 118287 for the later design of internal lighting type units.

The synchro motors of the internal lighting type unit are secured in a casting which is parallel to the front face of the director.

Note: The front cover of this unit can be removed only from the front while the production unit cover can be removed only from the light side of the director. See figures 53 and 57.

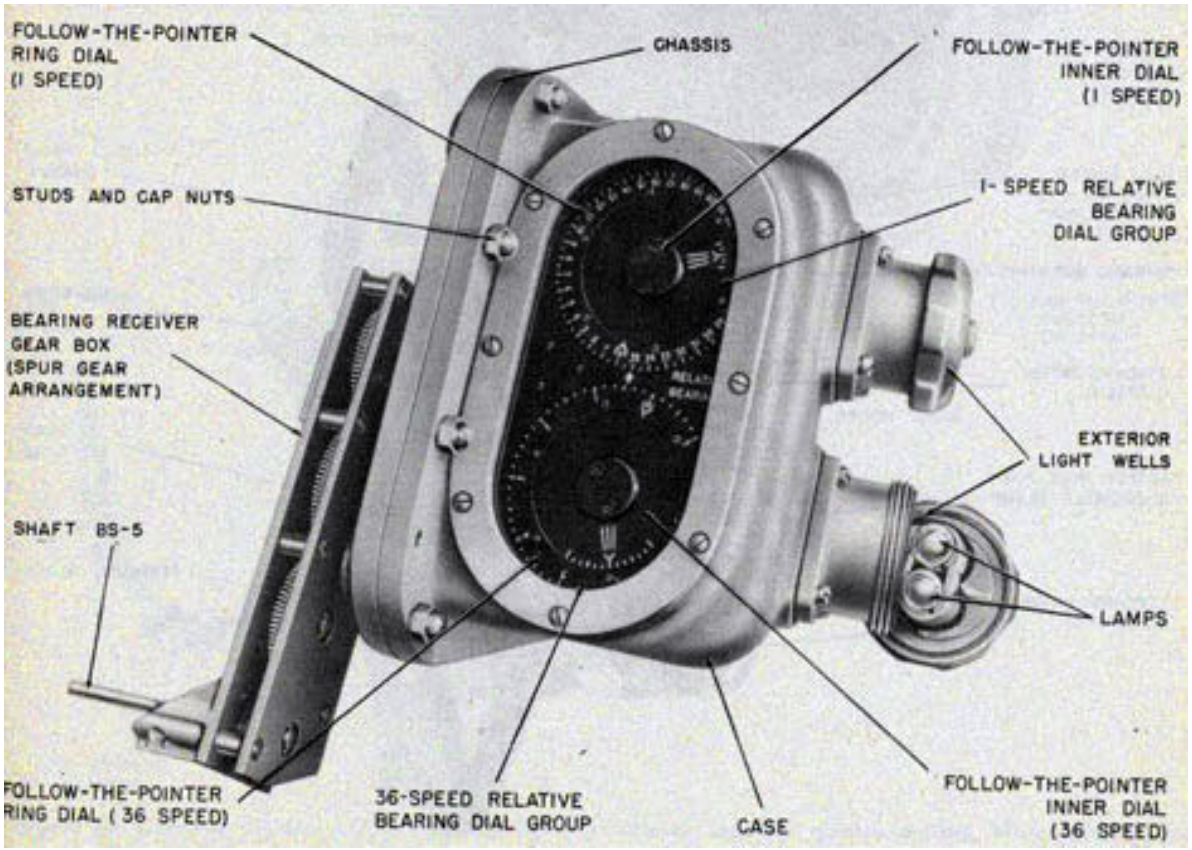

Figure 53-External lighting type bearing receiver with gear box connection to computer mechanism.

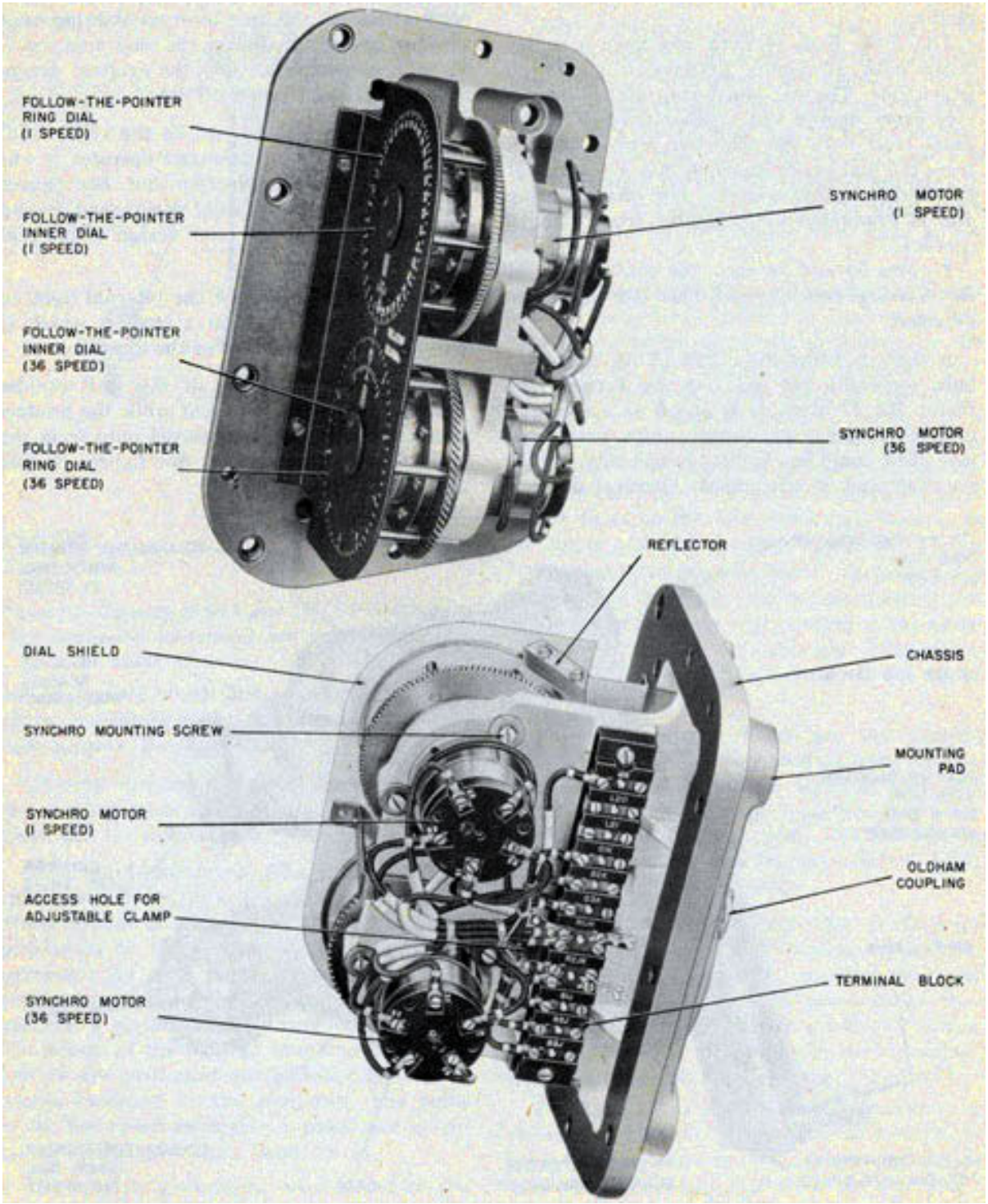

Figure 54-Right side and rear view of external lighting type bearing receive; showing terminal block and wiring connections.

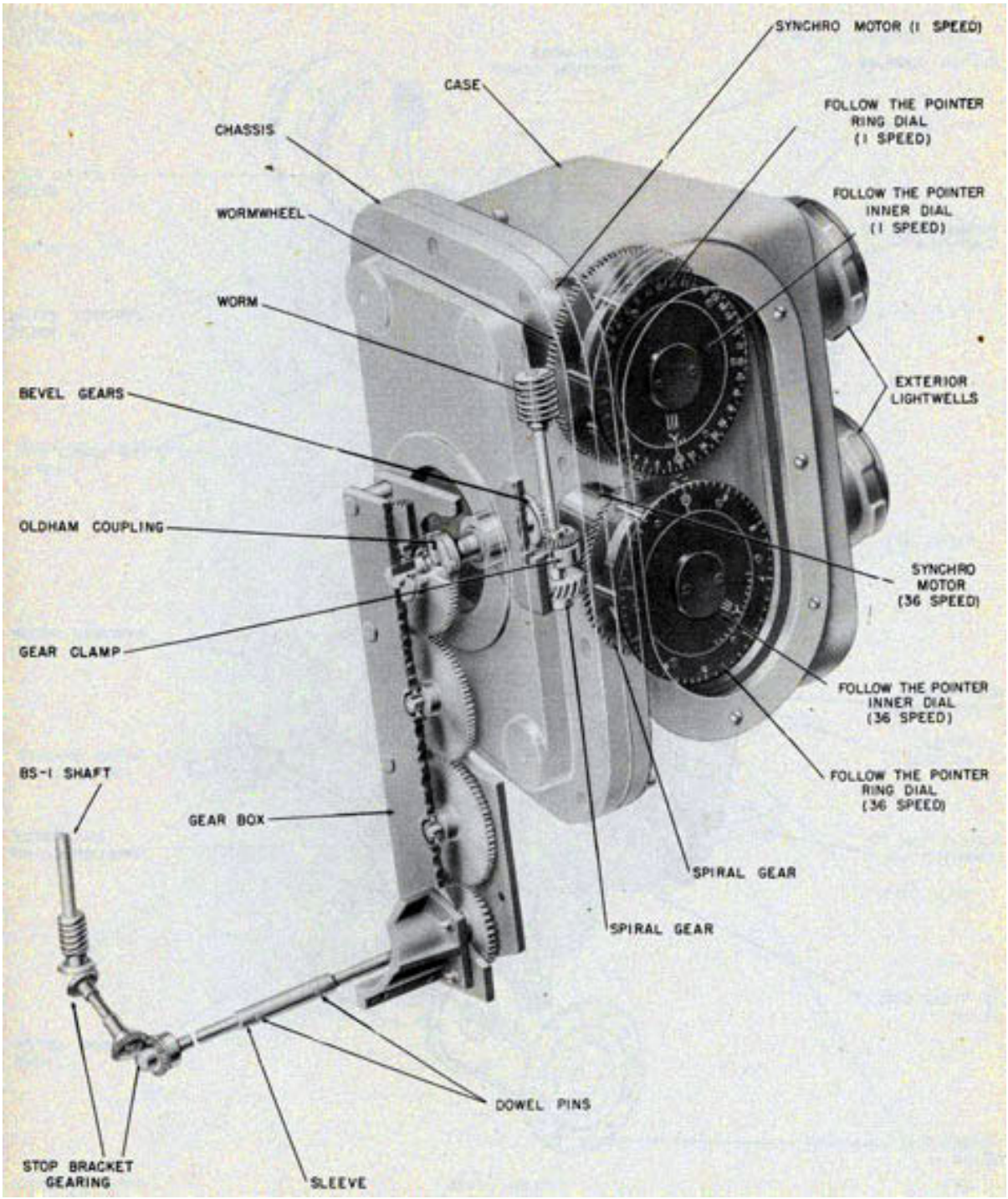

Figure 55-Cutaway of external lighting type bearing receiver showing synchro motors, dials, gearing, and shafting.

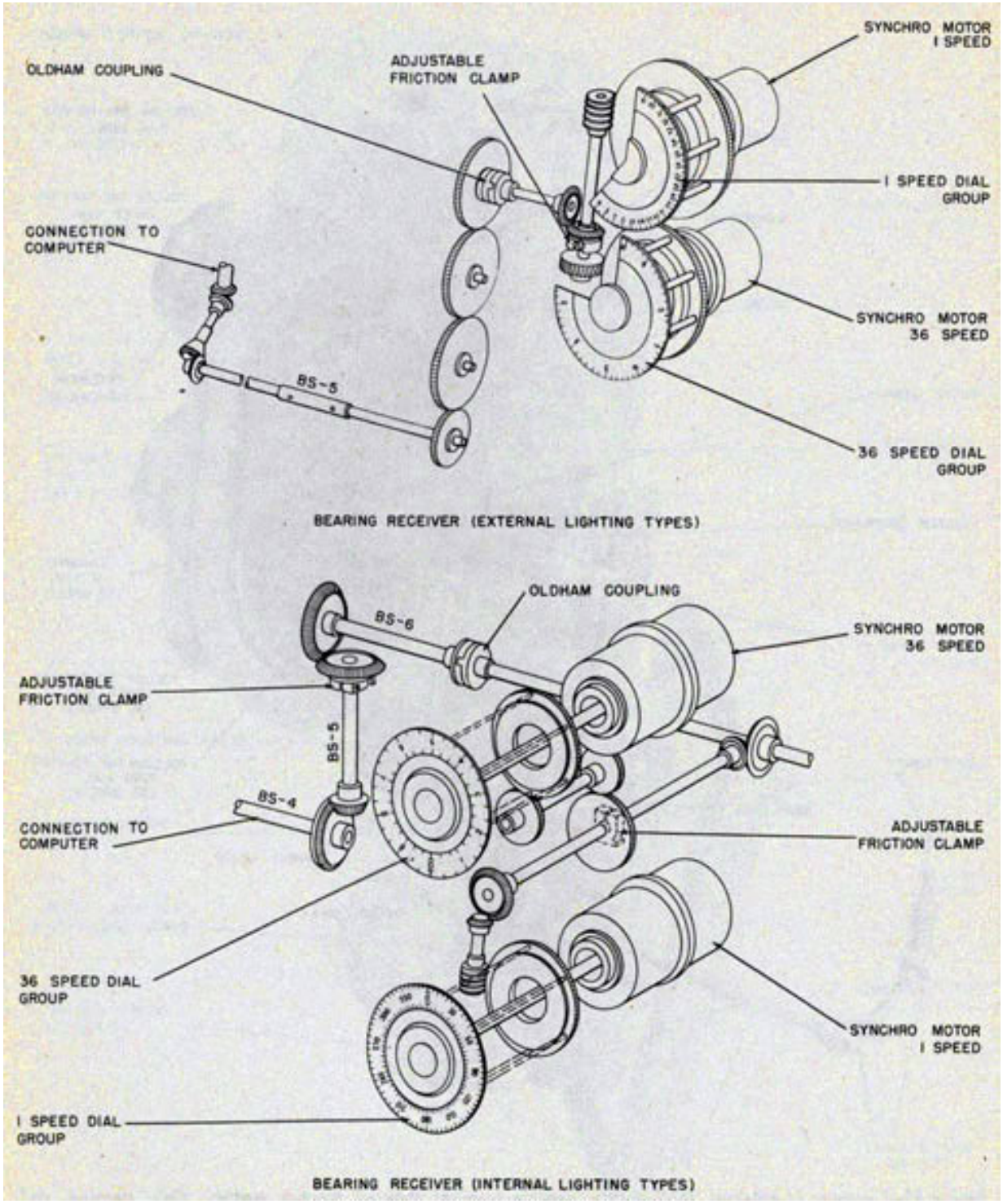

Figure 56-Diagram showing the differences between the gearing and shafting of the external and internal lighting types of bearing receivers.

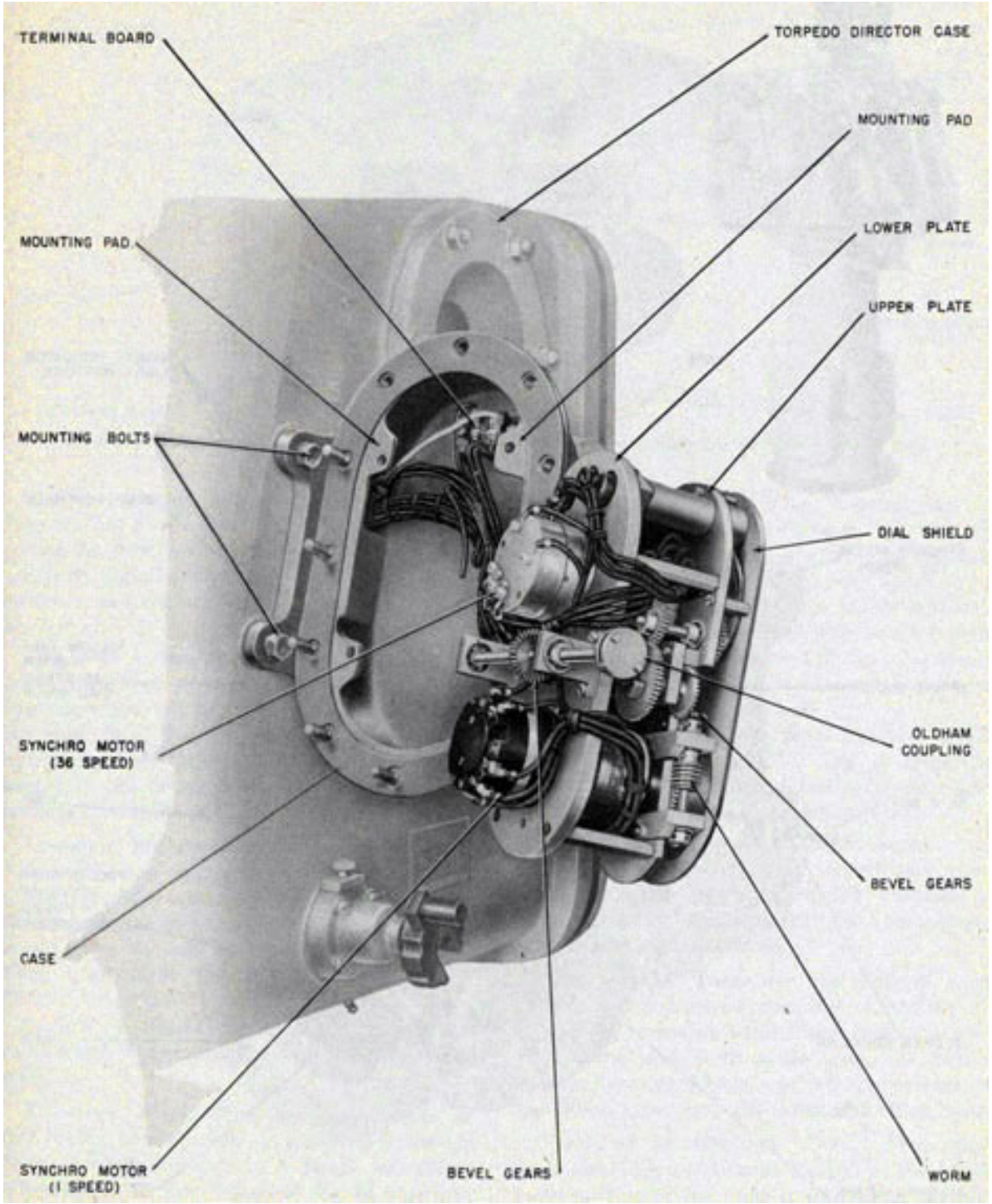

Figure 57-Internal lighting type bearing receiver partially removed from case to show wiring and shaft connection to computer mechanism.

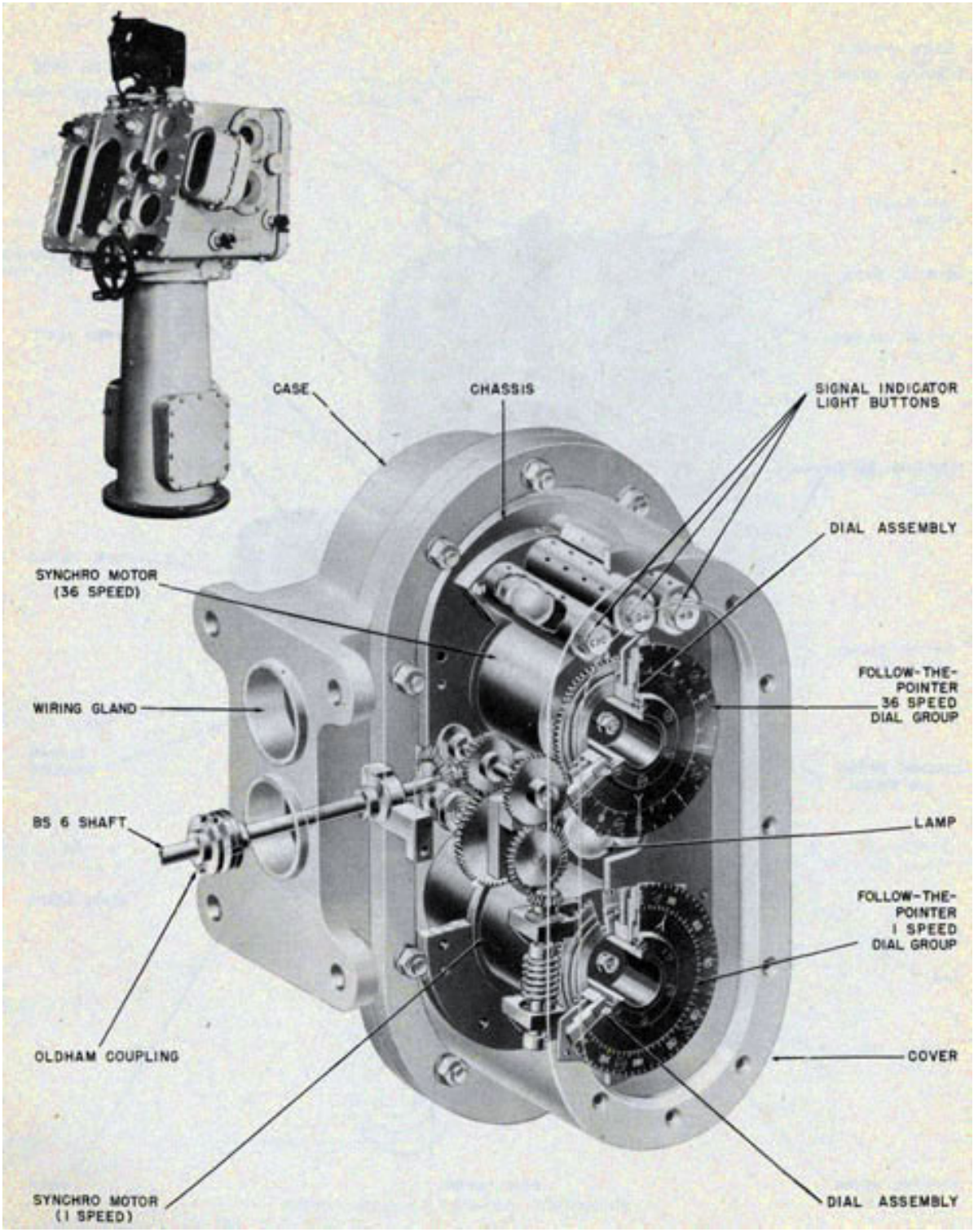

Figure 58-Cutaway of internal lighting type bearing receiver showing indicating signal lamps gearing and dial details.

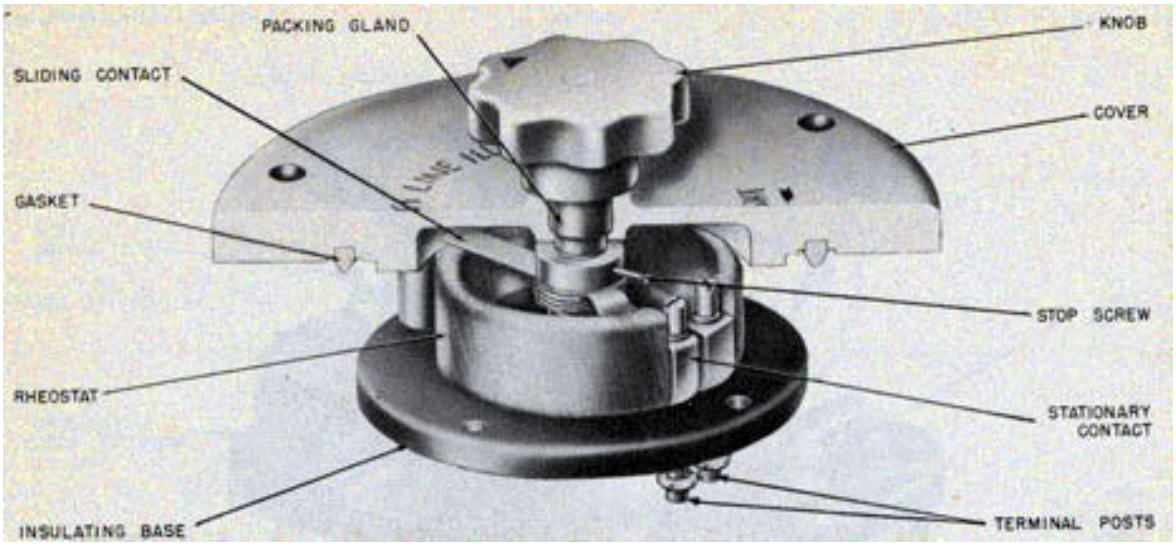

Figure 59-Cutaway of crossline illumination rheostat showing sliding contact and rheostat coil.

The three small indicator lights on the dial face are not now connected to the target designation or fire control systems of modern destroyers. Signal devices, external to the bearing receiver, are used to provide mark signal indication.

The later design unit is similar in operation and appearance to the original design except that there are only two small indicator lights on the dial face. See BuOrd Sk 118287. These lights, marked "MARK" and "ON", are connected to the target designation system in accordance with BuOrd Sk 118299.

Crossline Illumination Rheostat. This rheostat is mounted on the top of the rotation case to the left of the telescope. It is used for varying the intensity of the illumination of the telescope cross wires to suit external light conditions. The three light positions are "BRIGHT", "DIM", and "OFF".

Figure 59 shows the construction and arrangement of the crossline illumination rheostat.

Telescope Pivot. This assembly, made of cast bronze or aluminum, is mounted in the top of the torpedo director by a flange and forms the pedestal for the Telescope Mk 50 Mod 0 or 1. The major portion of the pivot extends down assembly consists of an outer housing and an interior pivot and telescope base, two circular ball- bearing assemblies-one at the top and one at the bottom-a worm gear assembly, a bottom cable sleeve and three watertight outlets for the electrical cables. The interior pivot and telescope base rotates 140 degrees within the outer housing which is supported on upper and lower bearing assemblies.

The telescope pivot is geared to the output shaft of differential DF-9 and is therefore turned through the calculated corrected sight angle with respect to the rotating case.

A fixed azimuth scale, attached to the outer housing, is graduated every degree and numbered every 10 degrees from 295 through 0 degrees to 65 degrees and may be used to read the approximate sight angle. See figure 60.

Hand Cranks. There are five types of hand cranks used for introducing inputs into the director: (1) training hand-wheel type, (2) own ship course and sight angle type, (3) target course, tube offset type, (4) latitude correction handknob type, and (5) intercept offset type.

TRAINING HANDWHEEL TYPE.-The four-spoke training handwheel, located in the lower right portion of the case, is secured to one end of the training shaft. Near the other end of the training shaft a worm

into the rotating case. See figure 60. The meshes with the training

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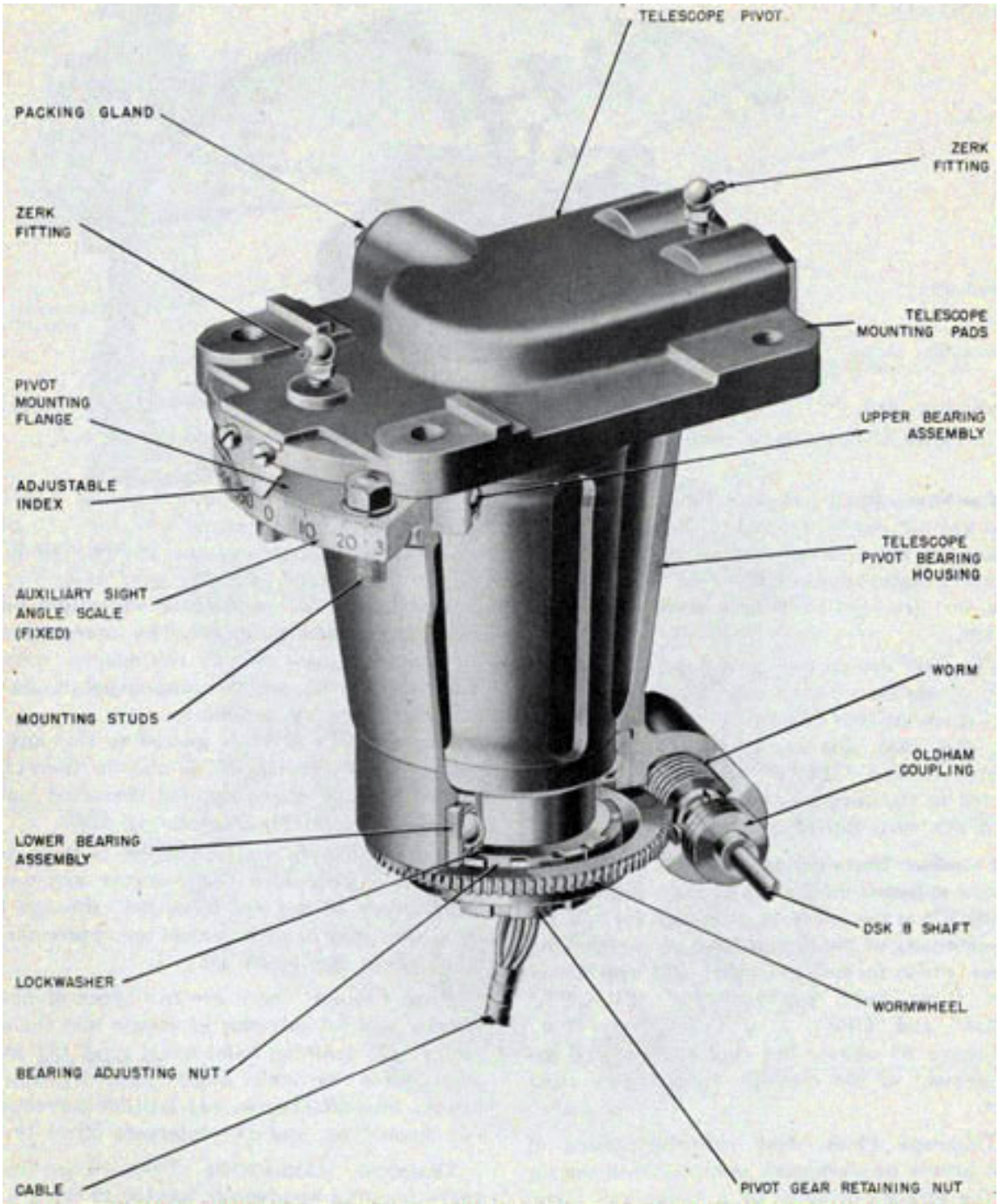

Figure 60-Cutaway of director telescope pivot showing telescope mounting pods, auxiliary sight angle scale, worm and wormwheel.

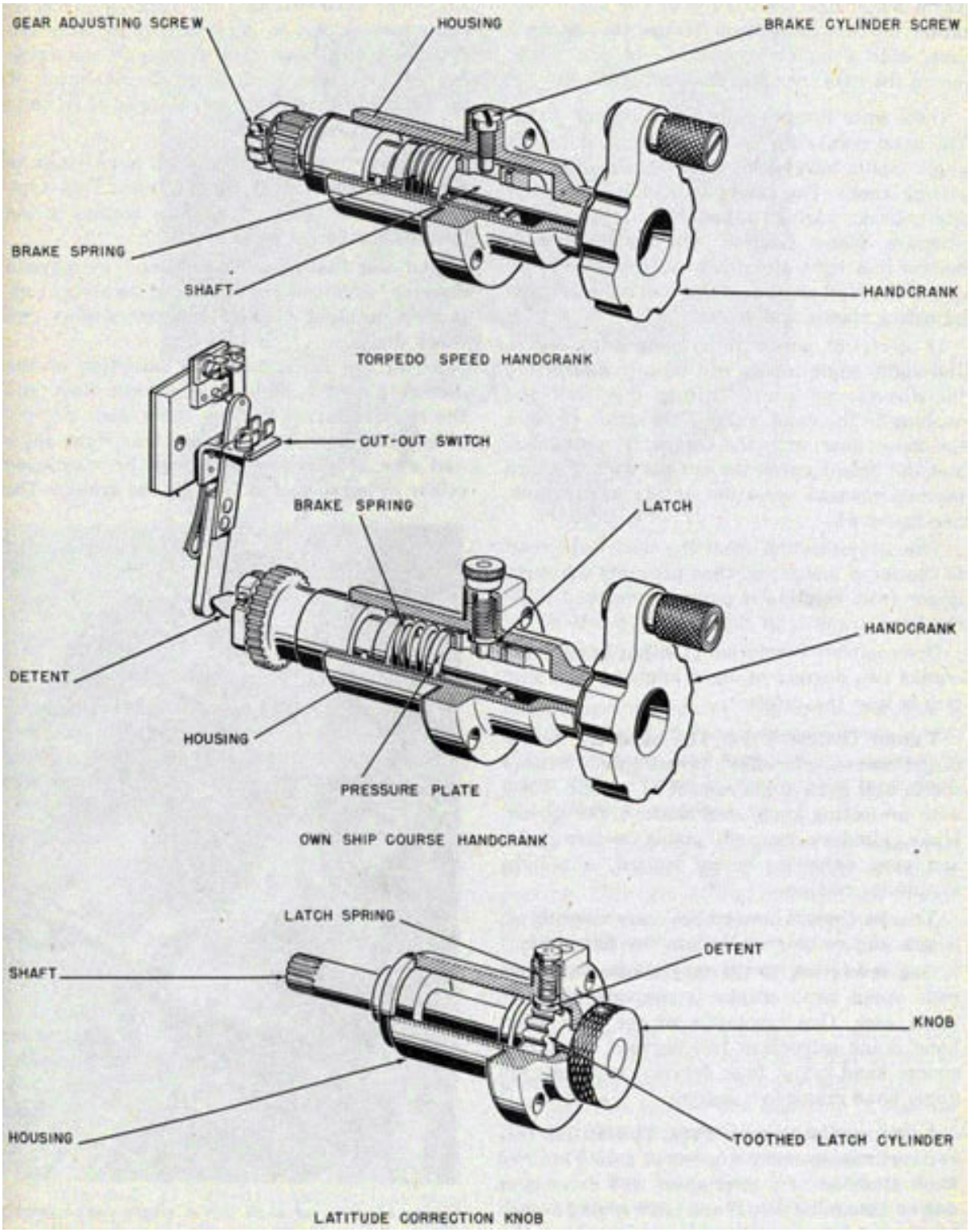

Figure 61-Cutaway of the torpedo speed and own ship course hand cranks and the latitude correction knob.

worm wheel fixed to the top of the stand. Rotation of this handwheel trains the rotating case, each complete revolution of the wheel moves the case two degrees. See figure 50.

OWN SHIP COURSE AND SIGHT ANGLE TYPE. The hand cranks for own ship course and sight angle inputs have small solid wheels with projecting knobs. The assembly consists of a steel shaft, brake spring, adjustable friction clamp pressure plate, friction washers and latch housed in a light aluminum casting. The inner end of the steel shaft contains a drive gear, gear adjusting clamp, and detent.

If electrical power fails, own ships course and sight angle inputs can be introduced into director by simply lifting the latch and pushing in the hand crank. This action engages the drive gear with the computer mechanism and the detent opens the cut-out switch which permits manual operation of the hand crank. See figure 61.

The cut-out switch opens the electrical circuit to the servo motor and thus prevents the servo motor from rotating if power is restored while the hand crank is in the engaged position.

One complete revolution of either hand crank cranks two degrees of sight angle or own ship course into the director.

TARGET COURSE TYPE. The hand cranks for target course, tube offset, target speed, torpedo speed, and gyro angle consist of a solid wheel with projecting knob, steel shaft, brake spring, brake cylinder screw, adjustable friction clamp and gear adjusting screw housed in a toothed latch cylinder and turning the knob causes the detent to click in passing over the cylinder teeth. Each click represents one-sixth degree correction. Each complete revolution of the knob is equivalent to two degrees of latitude correction. See figure 61.

INTERCEPT OFFSET TYPE. This hand crank is similar to the target course type. This type contains a toothed latch cylinder similar to the latitude correction hand crank.

Dial and Dial Gear Assemblies. The torpedo director, complete with bearing receiver, contains a total of 13 dial assemblies plus two check dials.

All of the dials, with the exception of the own ship course, sight angle, check dials, and the relative target bearing inner dials are positioned by hand crank inputs. The sight angle and own ship course dials can be positioned either by servo motors or by hand cranks. The

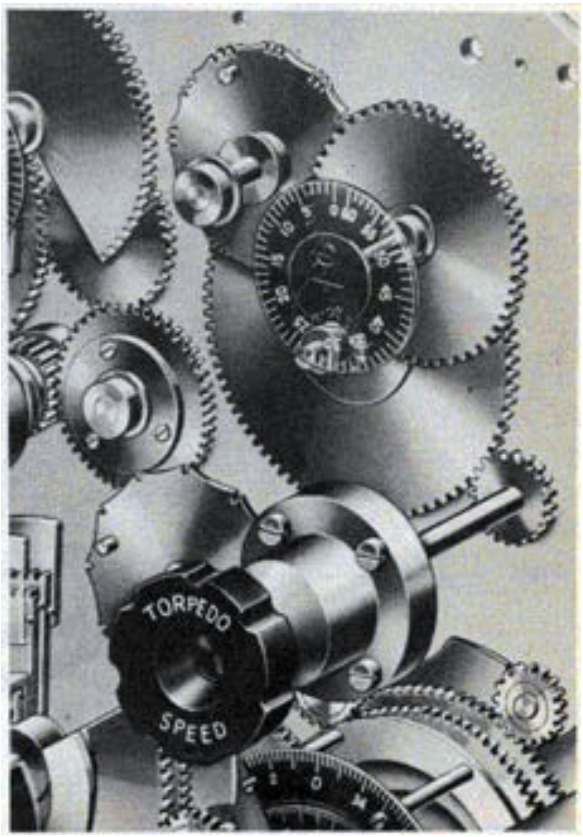

Figure 62-View of shaft driven single dial assembly showing details of intermittent type limit stop.

a light aluminum casting.

The handwheel assemblies vary slightly in length and drive gear design. See figure 61.

One revolution of the target speed and torpedo speed hand cranks is equivalent to two knots each. One revolution of the tube offset hand crank introduces two degrees, the target course hand crank four degrees, and the gyro angle hand crank five degrees.

LATITUDE CORRECTION TYPE. The latitude correction knob assembly consists of a solid knurled knob attached to a steel shaft and drive gear and an automatic detent and latch spring housed in an aluminum casting. The detent rides over

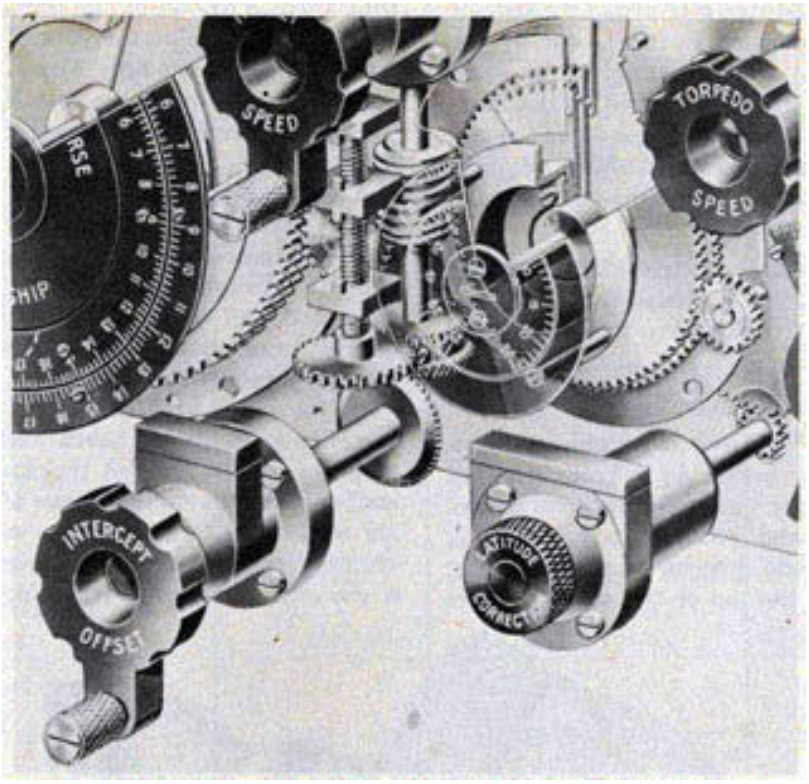

Figure 63-View of two dial type assembly.

check dials are positioned by torpedo course as produced in the director. The relative target bearing inner dials are positioned by the synchro motors in the bearing receiver.

The one-speed own ship course dial is driven mechanically by the output of the servo motor or by rotation of the own ship course hand crank. The dial is graduated every two degrees and numbered every 20 degrees from 0 to 360. The last zero has been omitted from the dial graduation, so a reading of "20" represents 200 degrees. When this dial is read against the fixed index, it indicates the amount of own ship course that has been set into the computing mechanism.

Dials that are driven mechanically by gearing and shafting are classified into four different dial arrangements: (1) single dial driven by a shaft, (2) two dial type, (3) three dial type, and (4) follow-the-pointer dial type.

The single dial type consists of a dial driven by a shaft. The dial is black with white translucent engraved figures. The single dial type is used for tube offset, target speed, torpedo speed, own ship course, and high-and-low speed zero reader dials. Figure 62 shows the arrangement of a typical single dial type.

The two dial type consists of an inner dial driven by a shaft and a ring dial driven by gearing. This type of dial arrangement is used for latitude correction and intercept offset and corrected sight angle and basic sight angle. Figure 63 shows the arrangement of a typical two dial type.

The three dial type consists of an inner dial driven by a shaft, a middle ring dial driven by gearing and an outer ring dial also driven by gearing. This type of dial assembly is used for the own ship and target main groups "A" and "B" and the torpedo course and gyro angle group. In this last group, the center or inner dial is a fixed dial and therefore does not rotate. Figure 64 shows the arrangement of a three dial type.

The follow-the-pointer dial group consists of an inner dial positioned by the rotor of the synchro motor and a ring dial driven by gearing. Two of these groups are used in the bearing receiver. One group operates at one-speed, the other at 36-speed. Figure 65 shows a typical arrangement of the follow-the-pointer dial group.

These inner dials are attached directly, by means of dial clamps and hubs, to the ends of the rotor shafts of the synchro motors.

A summary of the information given above is tabulated in table 3 page 67.

Director Stand. This unit is roughly cylindrical in with a worm driven by the training handwheel attached to the director case. The rotation of the training handwheel turns the case with respect to the stand. This rotation is limited by mechanical stops to approximately 390 degrees. See figure 66.

A cable clamp, bolted to the stand, anchors the lower end of the 60-conductor cable leading to the distribution panel in the case. The cable extends through a gland in the upper part of the stand. All twist in the cable is taken up between the clamp and the gland when the torpedo director case is trained. See figure 67.

In the lower portion of the stand are two rectangular terminal board access covers and mounting pads for

form and is bolted, by a bottom flange, to the bridge deck or to a raised director mount platform. The stand provides a ball-bearing base for the torpedo director case. A training circle, secured to the top of the stand, meshes the transfer and selector switches. In the flanged base of the stand are six watertight terminal tubes which admit the ship's wiring. In the lower base will be found a six-volt a-c lighting transformer.

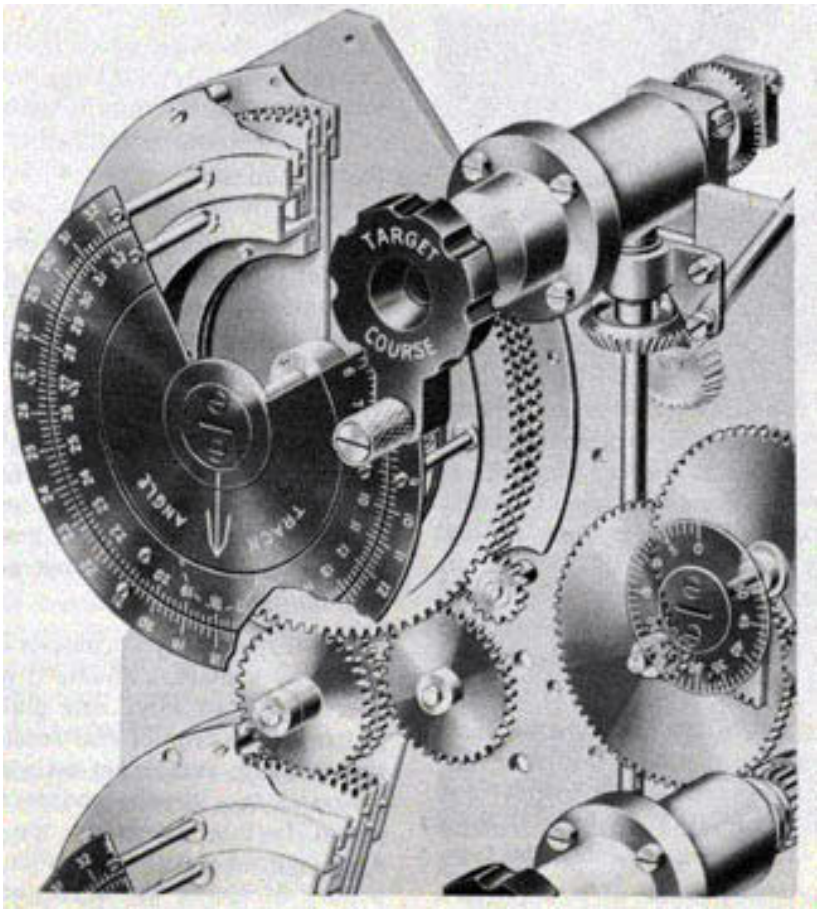

Figure 64-View of gear driven three dial type assembly.

TABLE 3

Dial Name	Type		Number of Dials			Turn Equivalents
	Gear	Shaft	One	Two	Three	
Tube Offset	X		X			1 turn equals 80 degrees
Target Speed	X		X			1 turn equals 60 knots
Torpedo Speed	X		X			1 turn equals 60 knots*
Own Ship Course, indicating	X		X			1 turn equals 360 degrees
Own Ship Course, zero reader		X	X			
Zero Reader, low speed	X		X			1 turn equals 360 degrees

Zero Reader, high speed	X		X			1 turn equals 10 degrees
Bearing Receiver, one-speed inner dial		X	X			1 turn equals 360 degrees
Bearing Receiver, 36-speed inner dial		X	X			1 turn equals 10 degrees
Bearing Receiver, one-speed ring dial	X		X			1 turn equals 360 degrees
Bearing Receiver, 36-speed ring dial	X		X			1 turn equals 10 degrees
Latitude Correction and Intercept Offset	X			X		turn equals 60 degrees
Basic Sight Angle and Corrected Sight Angle	X			X		1 turn equals 360 degrees
Own Ship Main Dial Group "A" Relative Target Bearing True Target Bearing and Corrected Sight Angle	X				X	1 turn equals 360 degrees
Target Main Dial Group "B" True Target Bearing Target Angle and Corrected Sight Angle	X				X	1 turn equals 360 degrees
Torpedo Course for forward tubes gyro angle	X				X	1 turn equals 360 degrees 1 turn equals 180 degrees
Torpedo Course for after tubes gyro angle	X				X	1 turn equals 360 degrees 1 turn equals 180 degrees

* One turn equals 60 knots for Mods 3, 4, 5, 6, 8, and 9.
One turn equals 50 knots for Mods 1, 2, and 7.

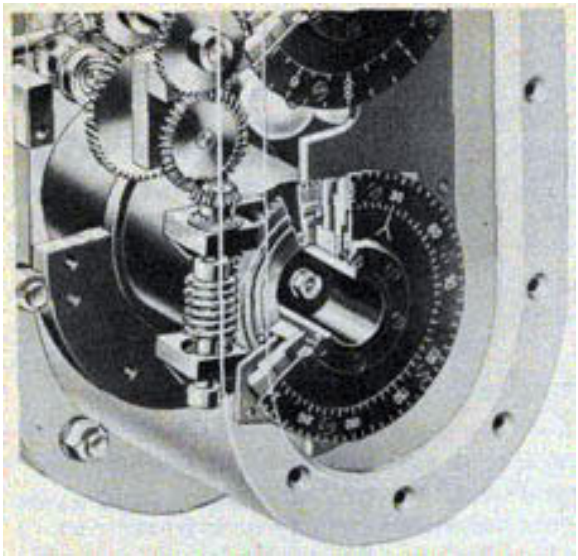

Figure 65-View of follow-the-pointer dial assembly.

TERMINAL BOARD. Interior mounting brackets hold seven terminal blocks which connect the director electrical circuits to the ship's wiring. See figures 67 and 68.

TRANSFER SWITCH. The transfer switch, mounted on a pad on the base of the stand, provides convenient changing of the illumination supply from the 115-volt a-c ship' circuit to a storage battery located near the director. The switch positions are "OFF", "BATTERY", "OFF" and "TRANSFORMER". See figure 68.

SELECTOR SWITCH. A three-position rotary selector switch on the stand controls all director circuits except the firing circuits, torpedo course and gyro angle orders. At the "ON" position the director is fully energized, at the "OSC OFF" position all circuits, except those for own ship course, are energized. At "OFF" position all controlled circuits are deenergized. See figure 69. If it is necessary to maintain the director in a stand-by condition set the selector switch to "OSC OFF". This will prevent wear to the own ship course unit.

TRAINING CIRCLE AND STOP. This assembly consists of an inner bearing, outer bearing, bottom plate, stop, training gear, and an upper ball-director case while the stand remains stationary. This stop limits the train of the rotating case to 390 degrees. See figure 70.

Gearing (Mechanical Diagrams)

Examination of figures 149 and 150 will show the differences in gearing between Torpedo Director Mk 27 Mods 1, 3, 4, 5, 7, 8 and 9, and Torpedo Director Mk 27 Mod 2.

SYSTEM ELECTRICAL COMPONENTS

The wiring diagrams consist of external and internal diagrams. The external wiring diagrams are the GA, 6PA, and 6R circuits and the internal wiring diagrams are for the Torpedo Director Mk 27 and the Torpedo Course Indicator Mk 1.

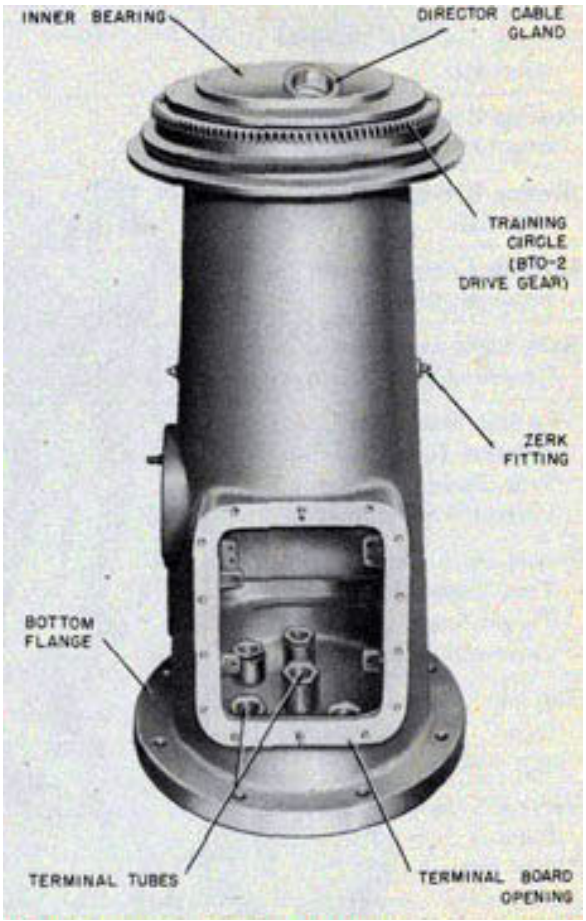

Figure 66-Director stand with terminal board cover removed to show terminal tubes.

bearing support. The circle is connected, by gearing, to the director train shaft and hand crank. Movement of the hand crank rotates the

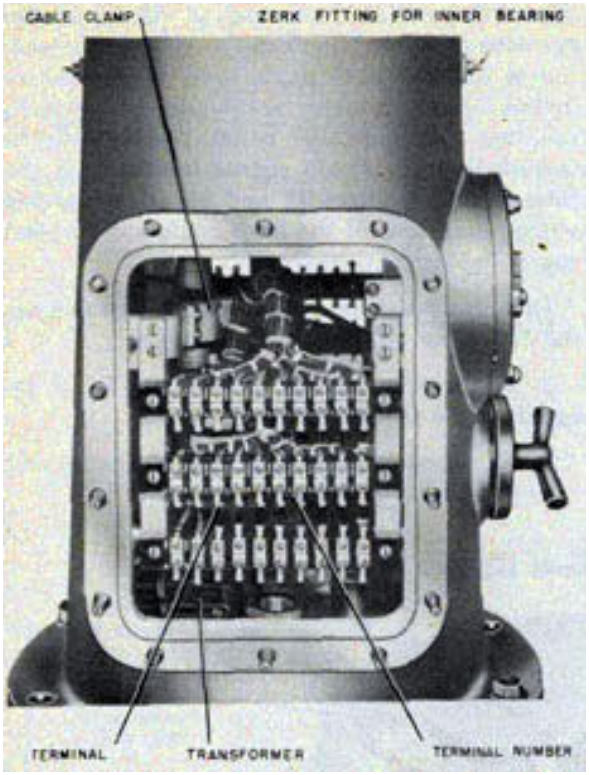

Figure 67-View of bottom of director stand showing front terminal boards, cable clomp, and transformer.

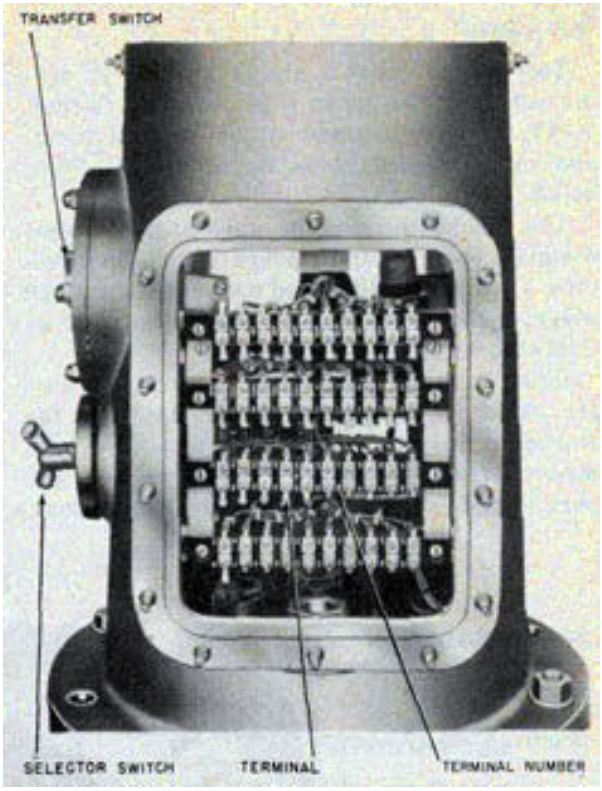

Figure 68-View of back terminal boards in stand.

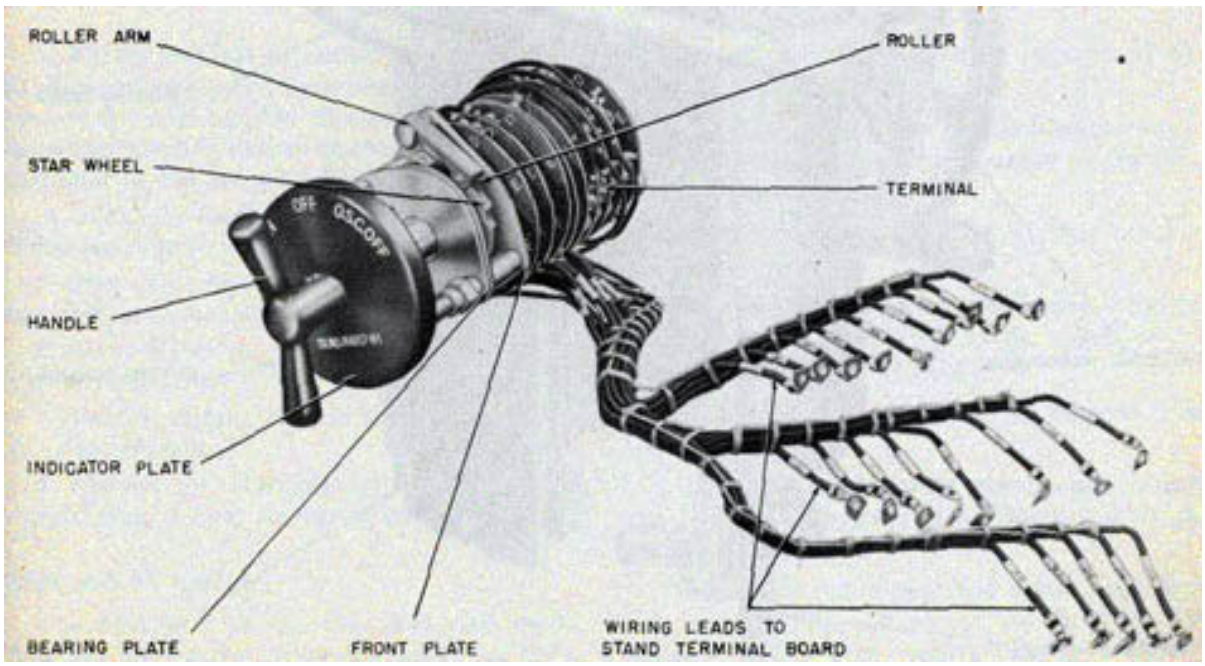

Figure 69-Selector switch assembly showing star wheel, roller arm, and wiring leads.

GA Circuit

This circuit, shown on figure 151, is subdivided into the gyro angle system (circuit 1GA), the torpedo course system (circuit 2GA), and other miscellaneous circuits (GA, 7GA. 24GA, and 27GA).

The torpedo course and gyro angle systems comprise the port and starboard torpedo directors, a transfer switch and associated fuse and overload indicator panel on the bridge, and an indicator at the tube mount.

Refer to figure 151. When the bridge transfer switch is turned to "STBD" position, the starboard torpedo director controls the tube mount. When turned to "PORT" position, the port torpedo director controls the tube mount.

When the switch is turned to either of the previous positions, the forward (No. 1) torpedo course and the gyro angle synchro generators in the selected director are connected, through the fuse and indicator panel, to the synchro motors in the torpedo course indicator at the tube mount. Figures 71 and 72 are simplified wiring diagrams of the gyro angle and torpedo course systems, respectively.

On ships fitted with two torpedo tube mounts the following additional is provided:

1. A transfer switch for Mount No. 2 located on the bridge.

2. A torpedo course indicator at the second tube mount.

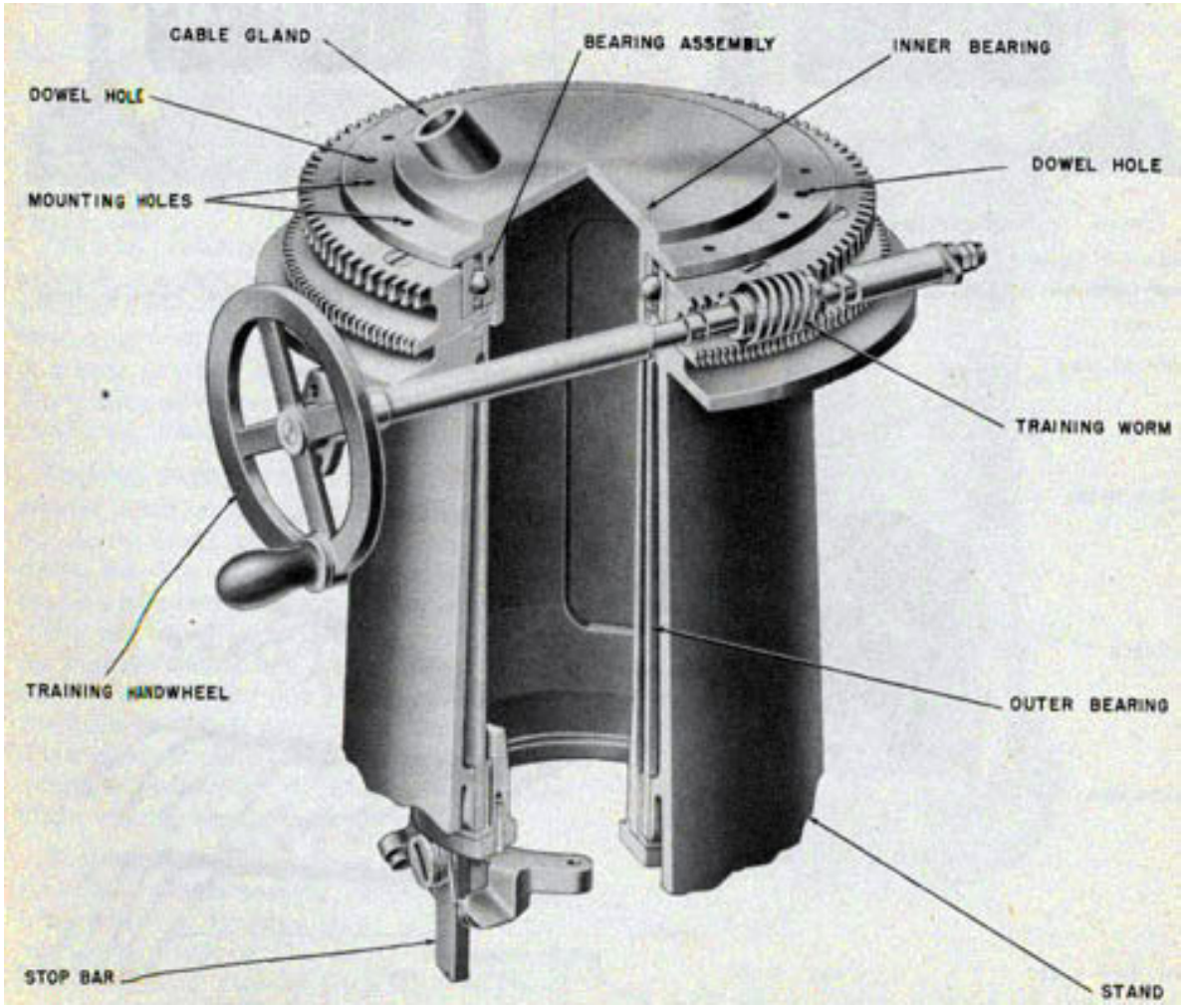

Figure 70-Training circle at top of director stand showing stop mechanism.

DESCRIPTION-SYSTEM ELECTRICAL COMPONENT

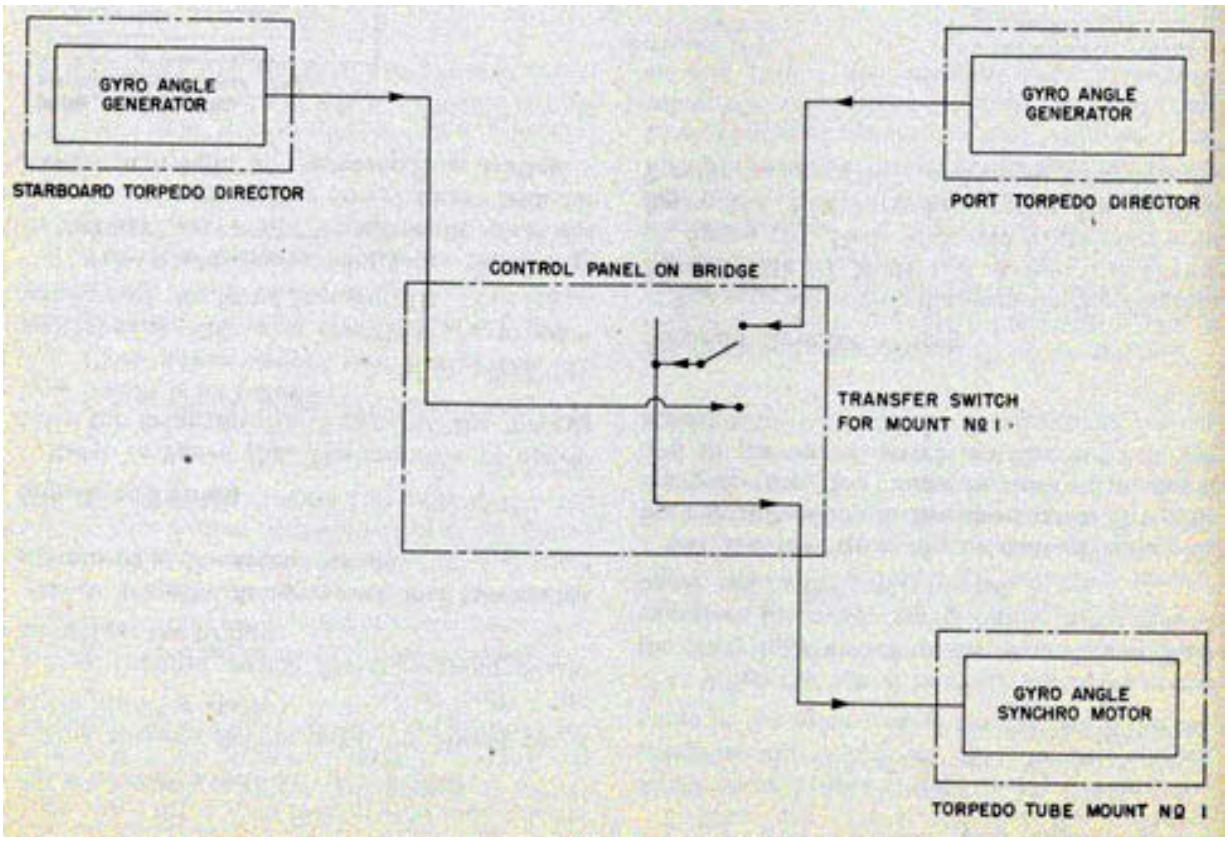

Figure 71-Torpedo control system-circuit 1GA, simplified wiring diagram.

3. Wiring suitable to connect the after (No. 2) torpedo course and gyro angle synchro generators in each torpedo director to the corresponding synchro motors in the torpedo course indicator at the second tube mount.

In addition, each torpedo director has the following inputs:

1. Own ship course (circuit 7GA) from the fire control switchboard.

2. Servo motor supply (circuit GA) from the I.C. switchboard.

3. Heater supply (circuit 27GA) from the 1.C. switchboard.

4. Six-volt D.C. (circuit 24GA) illumination supply from a local storage battery

6PA and 6R Circuit

The 6PA and 6R circuits, shown on figure 152,

The torpedo firing system (circuit 6PA) consists of:

1. Portable two-circuit contact makers adjacent to and the firing keys mounted on the torpedo directors.

2. A torpedo control panel at the director station.

3. A transfer switch on the bridge. This is the same switch referred to on pages 68 to 71 for circuit 1GA and 2GA.

4. A torpedo firing panel at the torpedo tube mount.

5. The 120-volt 60-cycle power supply from the I.C. switchboard and a 120/20-volt firing transformer.

The torpedo ready light and battle order system (circuit 6R) consists of the same contact makers, firing keys, control panel, transfer switch, and firing panel used in circuit 6PA.

are the torpedo firing and ready light circuits.

On ships fitted with two torpedo tube mounts the following additional is provided:

1. A torpedo control panel for Mount No. 2 at the director station.

2. A transfer switch for the second mount located on the bridge.

3. A torpedo firing panel and associated equipment at the second mount.

Signals and Firing

Refer to figure 152. The sequence of operations for firing the No. 1 panel of the torpedo tube mount is as follows:

1. Close power supply switches at the I.C. switchboard. This also energizes the primary winding of the firing transformer.

2. Turn the transfer switch on the bridge t "STBD" or "PORT" position to select the controlling station. This energizes the transfer h pilot light at the controlling station.

3. Close the snap switch for No. 1 Barrel on the control panel at the director station. This energizes the indicator light in the control panel in the mount panel for the No. 1 Barrel.

4. When the barrel is ready for firing, close the ready light switch on the mount panel. This energizes the mount ready lights in the mount panel and in the control panel.

5. Close the firing key or contact maker at the control station to fire the barrel. This also energizes the "fire" light in the control panel and in the mount panel and the horn at the mount.

Torpedo Director Wiring

The internal wiring diagram for the Torpedo Director Mk 27 Mods 1, 3, 4, and 5 is shown on figure 153. Mods 7, 8, and 9 are shown on figure 154. For Torpedo Director Mk 27 Mod 2 refer to figure 155. Additional transmitters,

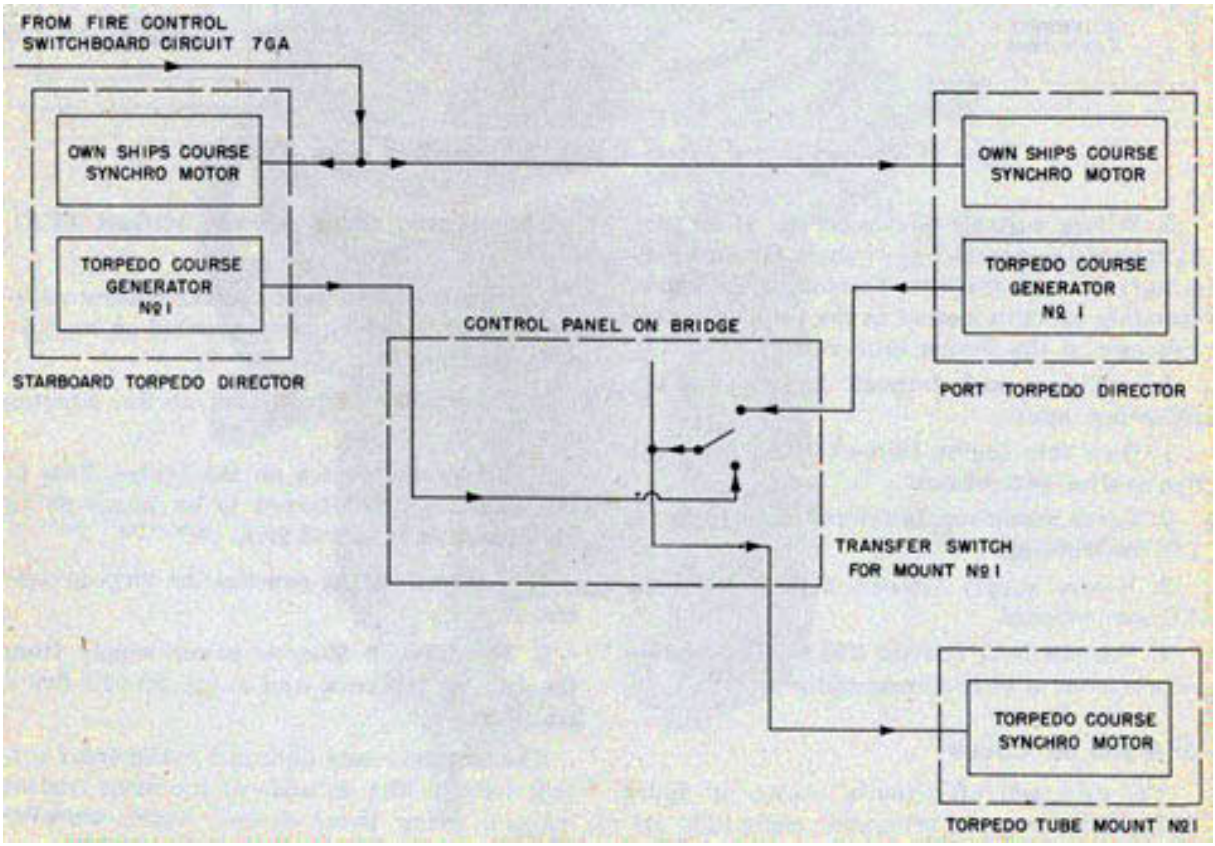

Figure 72-Torpedo control system-circuit 2GA and 7GA, simplified Wiring diagram.

for sending information to the central group of torpedo tubes are required for Torpedo Director Mk 27 Mod 2.

Torpedo Course Indicator Wiring

The internal wiring diagram of the Torpedo Course Indicator Mk 1 Mod 0 is shown on figure 79. The Torpedo Course Indicator Mk 1 Mod 1 is the same electrically as the Mk 1 Mod 0 except for the removal of the plug board. L1 and L2 connections are made directly to the main terminal board as shown on BuOrd Dwg 180609.

The wiring for Torpedo Course Indicator Mk 1 Mod 2 (original design) is shown on BuOrd Dwg 180685. The wiring for the later design is shown on figure 80. Torpedo course indicators mounted on DD 421 and upward contain no lighting

shown on BuOrd Dwg 238028. The wiring for the Torpedo Course Indicator Mk 1 Mod 4 is the same as the later Torpedo Course Indicator Mk 1 Mod 2.

Terminal Board. The terminal board, secured to interior machine pads in the rear of the case, consists of a single strip with the necessary terminals for connecting the input synchro supply leads to the synchro motors and the input dial illumination leads to the lightwells. See figure 75.

TORPEDO COURSE INDICATOR MK I MODS 0 TO 4

The torpedo course indicator indicates torpedo course, torpedo course order, gyro angle, gyro angle order, and actual tube train as received mechanically from the training rack of the tube mount.

transformers. The wires for the 6-volt lighting circuit enter the case in a separate terminal tube connecting to terminals 14 and 15 on the terminal board. The wiring for Torpedo Course Indicator Mk 1 Mod 3 is as Mods 0 to 4 are somewhat alike in construction and physical appearance and since the Mod 4 indicator is the production instrument, it will be described in detail. The difference

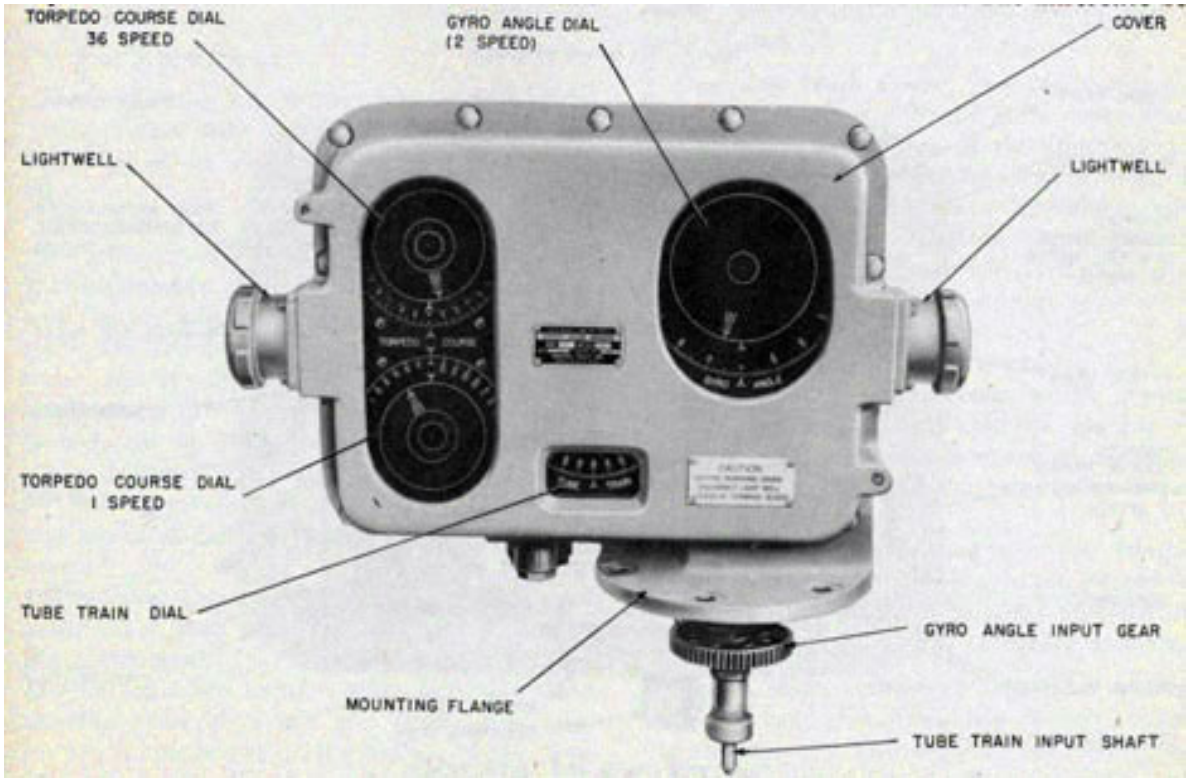

Figure 73-Front view of Torpedo Course Indicator Mk 1 Mod 4.

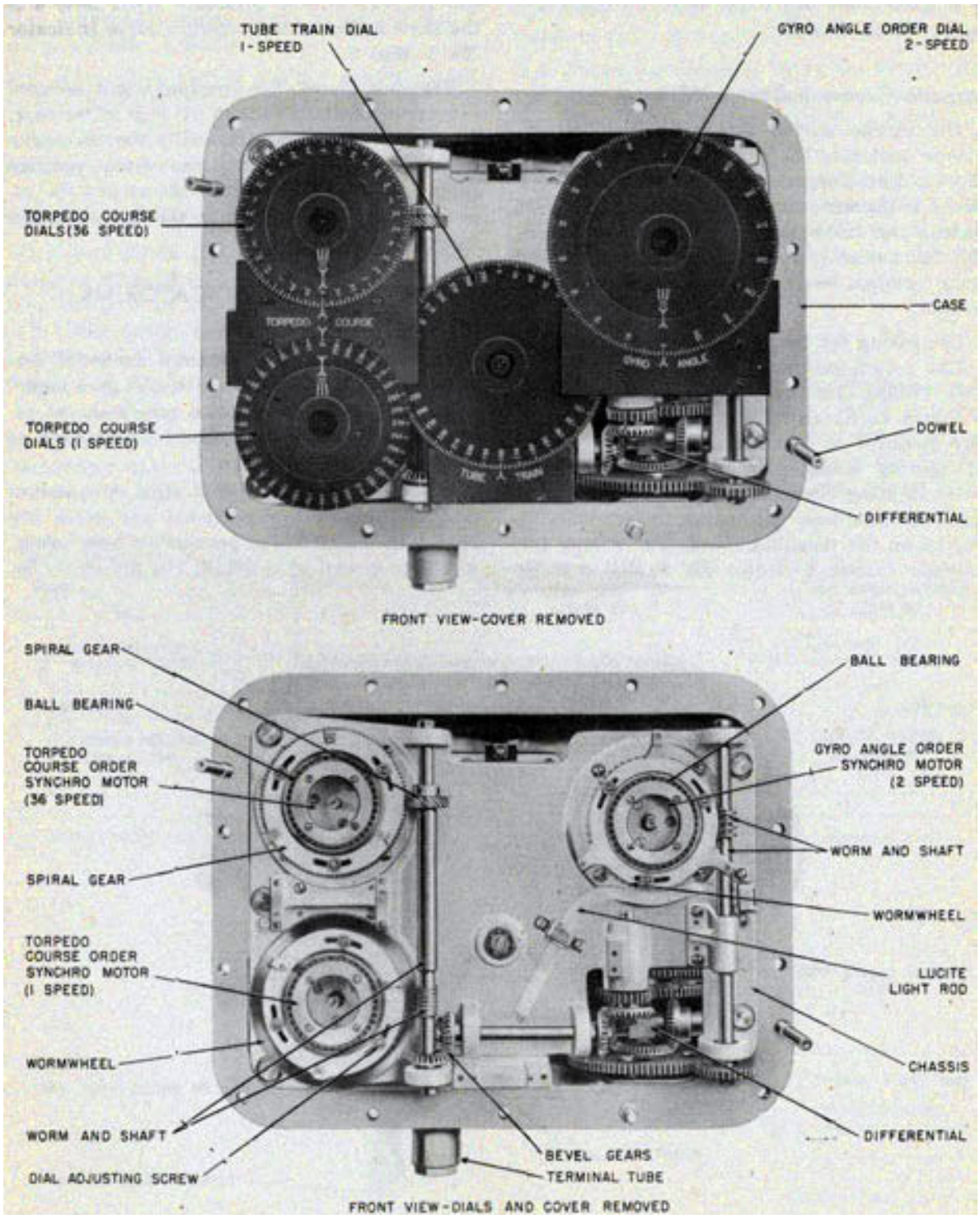

Figure 74-View showing interior details of indicator.

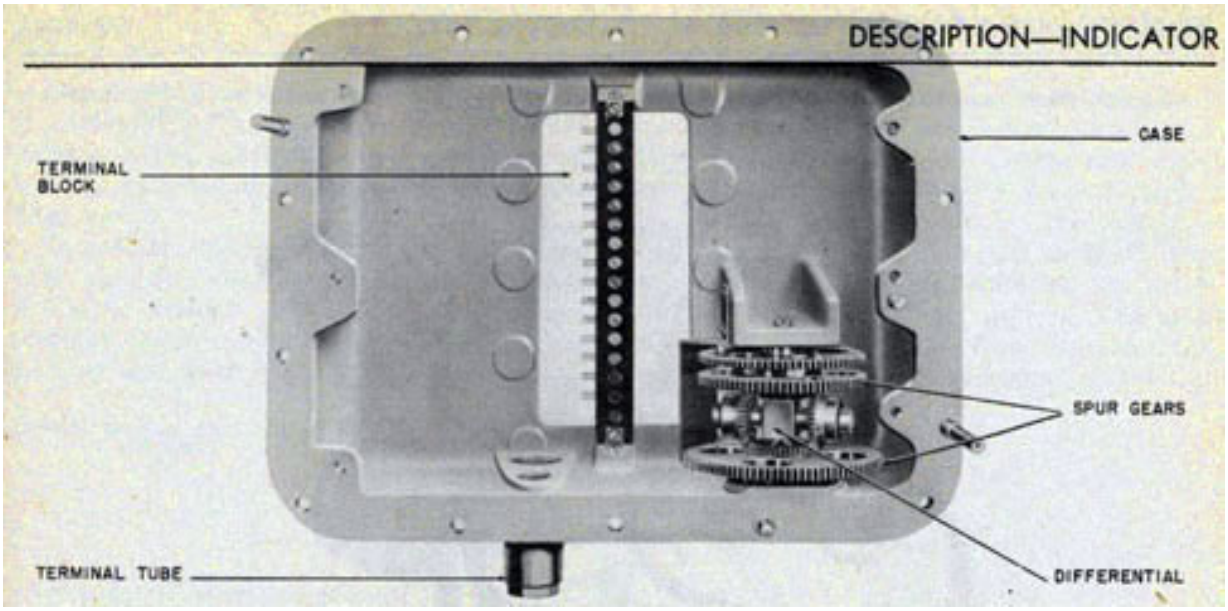

Figure 75-Interior view of indicator showing differential and terminal board.

between Mod 4 and the previous mods are explained in the Introduction chapter, page 13.

In the Mod 3 indicator one major difference occurs. An explanation for this will he given in later paragraphs of this section.

Physical Appearance

The indicator is approximately 14 inches high (2O 1/4 inches with the input shaft attached), 21 inches wide, and 9 inches thick. See figure 73.

The indicator mounting ring is secured to the torpedo course attachment. Figure 6 shows the relationship of the torpedo course indicator and the torpedo course attachment.

On the front of the indicator a removable cover contains three glass-covered openings behind which are located the one-and 36-speed torpedo course dials, the gyro angle dials and the tube train dial. The dials are illuminated by two lightwells, one mounted on the right and one mounted on the left side of the front cover.

The tube train output shaft and the gyro angle input gear protrude from the bottom of the instrument. Two terminal tubes, one for 115-volt

Component Parts

The principal parts of the torpedo course indicator are the case and front cover; chassis, dial, and motor unit; the differential; input shaft; gearing; and terminal board. See figures 74 and 77.

Case and Front Cover. The cast aluminum alloy case together with the front cover houses the internal mechanism of the indicator. See figure 73. The case contains two openings, one on the front side for access to the dial and motor unit and one on the rear side for access to the terminal board. A flange on the front of the case is used for bolting the front cover to the case.

Inside the case, integral mounting pads and brackets support the chassis which contains the dial and motor unit and the gearing and shafting.. The indicator is mounted, by means of a circular flange to the top of the torpedo course attachment.

The aluminum-alloy front cover contains three glass covered openings which protect the dials of the indicator. The glass windows are kept watertight by means of rubber gaskets.

Chassis, Dial, and Motor Unit. The unit consists of a cast aluminum-alloy chassis supporting the one- and 36-speed torpedo course synchro motors, the

synchro supply leads and the other terminal tube for 6-volt dial illumination supply leads are located in the bottom of the case. Mounted on the rear of the indicator case is the terminal board cover.

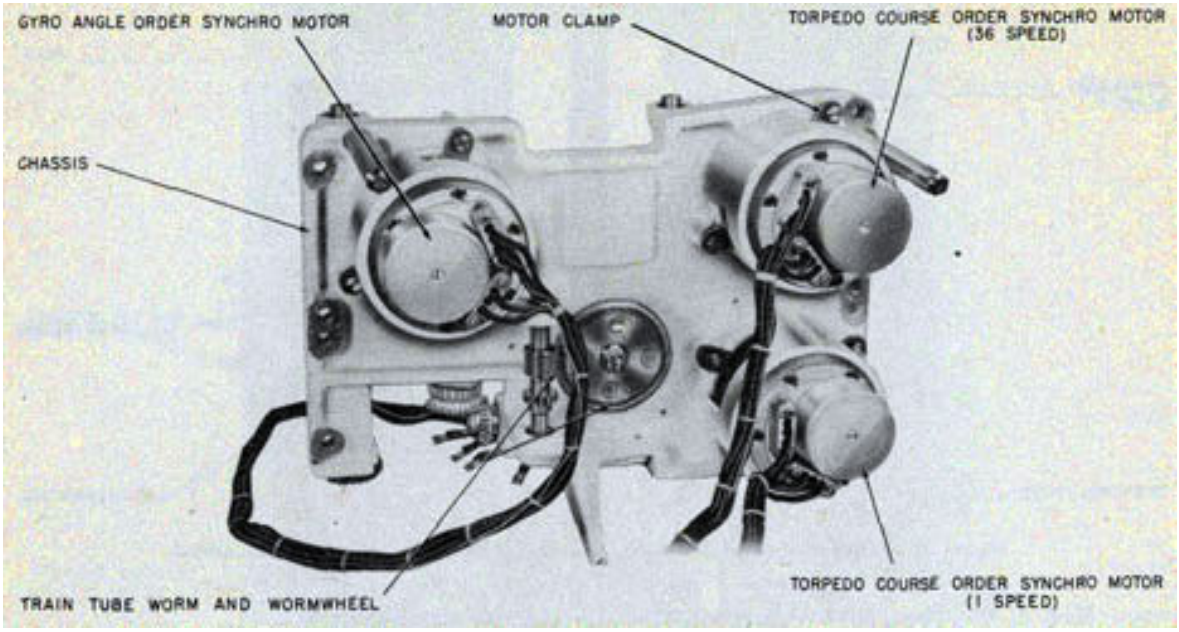

Figure 76-Torpedo course indicator chassis showing synchro mounting, rear view.

tube train dial and the gearing arid shafting. See figures 74 and 76. An illumination transformer will be found on the chassis of the Mod 0, 1, and 3 indicators.

The dial and motor unit for the Mod 3 indicator does not include the two-speed gyro angle synchro motor and follow-the-pointer dials. In the Mod 3 instrument the follow-the-pointer dials are replaced with a single dial with the same graduations as the follow-the-pointer ring dial.

The three synchro motors, type 5F, are secured to the chassis by motor clamps. The left-hand side of the chassis supports two torpedo course synchro motors, the 36-speed motor is at the top and the one-speed motor at the bottom. The gyro angle synchro motor is located in the upper right-hand side. See figure 76. Attached to the rotor of each torpedo course dials, two-speed gyro angle synchro motor, gyro angle dials,

speed ring dial is graduated and numbered every 10 degrees from 0 to 360. The 36-speed ring dial is graduated every 5 minutes and numbered every 20 minutes from zero to 10 degrees. To obtain the correct value of the torpedo course signal from these dials the indexes of the ring dials must be first positioned to match the indexes of the inner dials and then the graduation of the ring dials read against the fixed index. See figure 13.

The two-speed gyro angle follow-the-pointer dials consist of an inner dial, positioned electrically by the director gyro angle signal which moves the rotor of the synchro motor, and a ring dial positioned by gyro angle received mechanically from the torpedo course attachment. The ring dial is graduated every degree on either side of zero. On the left of the zero, the dial is graduated for 85 degrees with every 10 degrees numbered from 0 to 80 degrees. On the right of the zero the dial is also graduated for 85 degrees

of the synchro motors is an inner dial of one-and 36-speed follow-the-pointer dial group. These, dials, marked by a single index, are positioned by the electrical signals received by the synchro motors. The ring dials are positioned mechanically by torpedo course, the output of the indicator differential.

All the dials are black with engraved white translucent figures or graduations. The one-

with every 10 degrees numbered by the graduations from 360 to 280 degrees. The value of gyro angle set into the torpedoes is obtained by reading the ring dial against the fixed index.

The tube train dial is driven mechanically at one-speed by tube train received from the training

rack of the torpedo tube mount. The dial is graduated every two degrees from 0 to 360 degrees. Actual tube train can be seen by reading the graduations of the dial against the fixed index.

To indicate the unsafe firing sector on the tube train dial, the engraved degree markings should be masked out by application of blue or black enamel or lacquer. The numerals indicating tube train should be left visible.

The gearing and shafting of the dial and motor unit operate the various mechanical dials. For example, the torpedo course ring dials are positioned mechanically by gearing, receiving its drive from the output of the differential. The gyro angle ring dial is positioned mechanically by gearing, receiving its drive from the gyro angle input gearing. The tube train dial receives its drive from the tube train input shaft by means of gearing.

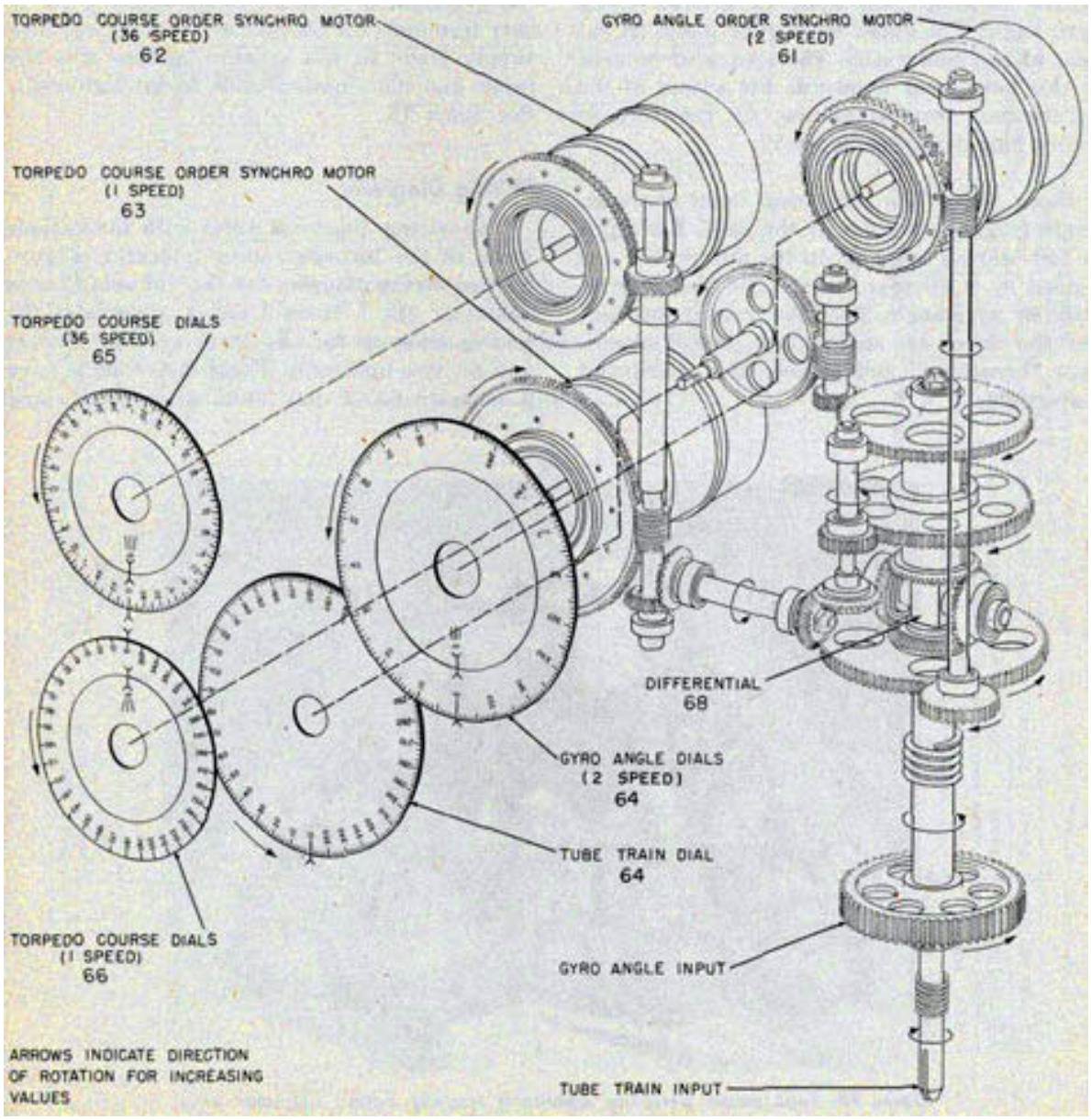

Figure 77-Torpedo Course indicator Mk Mod 4-schematic mechanical diagram

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Differential. The bevel gear type of differential is located in the lower right hand part of the case. Figure 75, shows the construction and arrangement of the various parts of the differential. The spider of the differential is secured to the tube train input shaft. A spur gear secured to the upper end of the tube train input shaft transmits tube train to drive the tube train dials. The lower input bevel gear of the differential, secured to the sleeve that fits around the tube train input shaft, is driven by gyro angle. The upper bevel gear is the output gear of the differential. The spur gear secured to this bevel gear transmits the output of the differential, torpedo course, to the torpedo course ring dials. See figure 77.

Input Shaft. The tube train input shaft extends from the bottom of the case. The shaft is ball-bearing mounted in the differential and guided by a circular sleeve. The sleeve is rotated by gyro angle. The tube train input shaft and the sleeve are spring-back packed to prevent "breathing" and to keep the instrument watertight.

Gearing. Figure 77, the gearing diagram for the Torpedo Course Indicators Mk 1 Mods 0, 1, 2, and 4, shows the arrangement of the gearing and shafting. For the Mod 3 indicator the gearing is the same except that the Mod 3 does not have a two-speed gyro angle order synchro motor.

Terminal Board. The terminal board, secured to interior machined pads in the rear of the case, consists of a single strip with the necessary terminals for connecting the input synchro supply leads to the synchro motors and the input dial illumination leads to the lightwells. See figure 75.

Wiring Diagrams

The wiring diagrams differ with the various mods of the torpedo course indicator. Figure 80, the wiring diagram for the Torpedo Course Indicator Mk 1 Mods 2 and 4, illustrates the wiring hook-up for the three synchro motors and the two lightwells. These instruments have a separate 6-volt dial illumination supply and

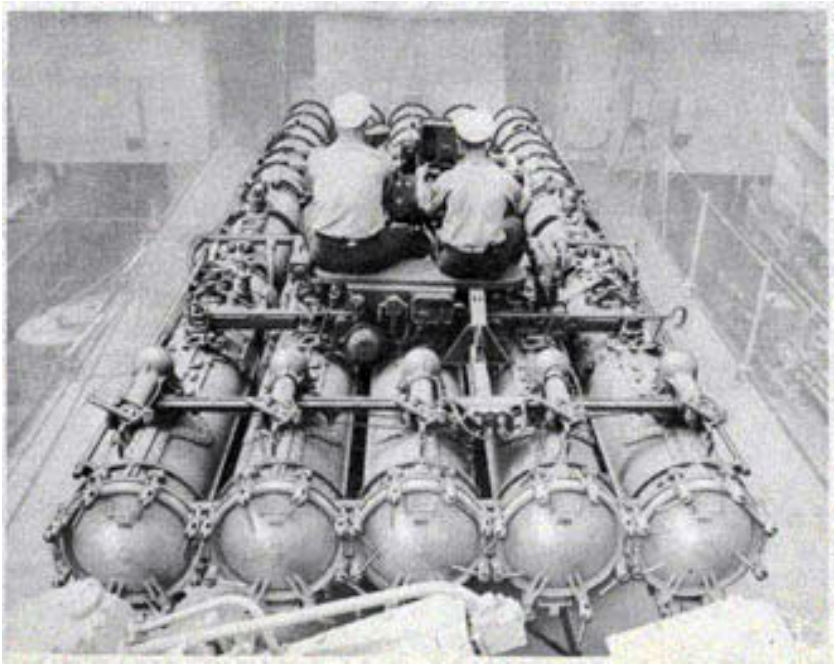
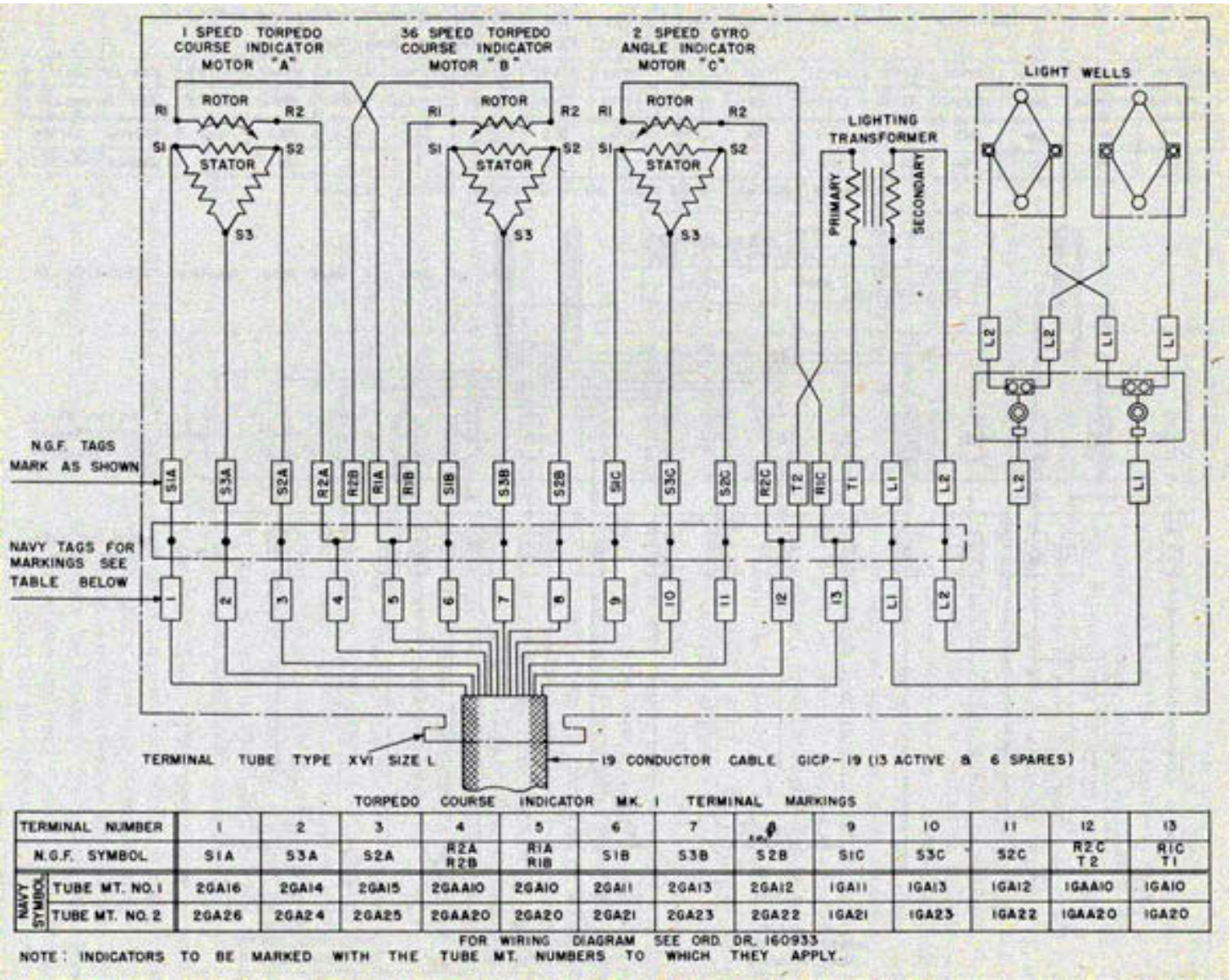


Figure 78-Tube mount personnel operating torpedo course indicator and gyro setting mechanism.

DESCRIPTION-INDICATOR



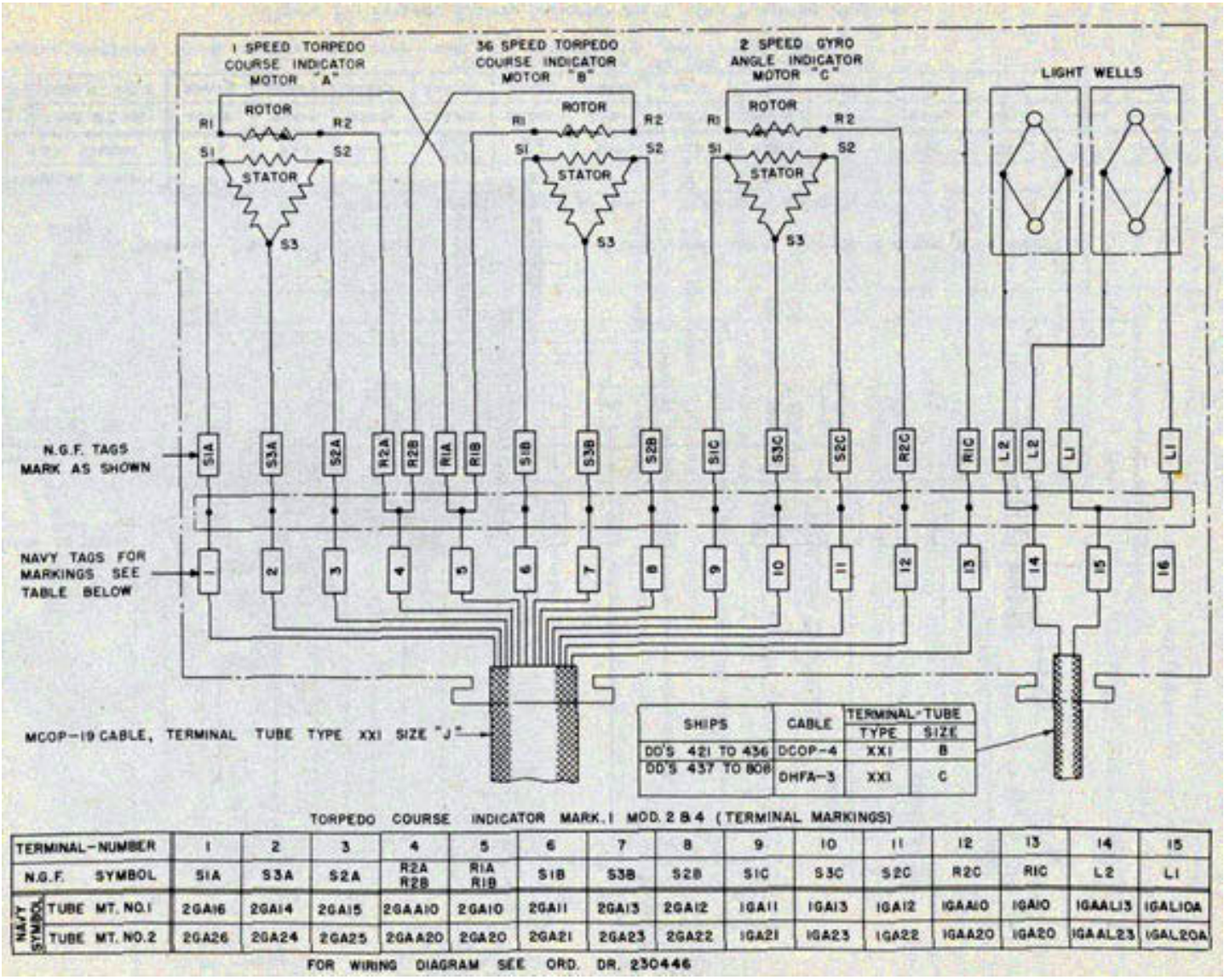
TORPEDO COURSE INDICATOR MK. 1 TERMINAL MARKINGS

TERMINAL NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13
N.G.F. SYMBOL		S1A	S3A	S2A	R2A R2B	R1A R1B	S1B	S3B	S2B	S1C	S3C	S2C	R2C T2	R1C T1
NAVY SYMBOL	TUBE MT. NO. 1	2GA16	2GA14	2GA15	2GAA10	2GA10	2GA11	2GA13	2GA12	1GA11	1GA13	1GA12	1GAA10	1GA10
	TUBE MT. NO. 2	2GA26	2GA24	2GA25	2GAA20	2GA20	2GA21	2GA23	2GA22	1GA21	1GA23	1GA22	1GAA20	1GA20

FOR WIRING DIAGRAM SEE ORD. DR. 160933

NOTE: INDICATORS TO BE MARKED WITH THE TUBE MT. NUMBERS TO WHICH THEY APPLY.

Figure 79-Torpedo Course Indicator Mk 1 Mod 0-wiring diagram.



TORPEDO COURSE INDICATOR MARK 1 MOD. 2 & 4 (TERMINAL MARKINGS)

TERMINAL-NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
N.G.F. SYMBOL	S1A	S3A	S2A	R2A R2B	R1A R1B	S1B	S3B	S2B	S1C	S3C	S2C	R2C	R1C	L2	L1
NAVY SYMBOL TUBE MT. NO.1	2GA16	2GA14	2GA15	2GAA10	2GA10	2GA11	2GA13	2GA12	1GA11	1GA13	1GA12	1GAA10	1GA10	1GAAL13	1GAL10A
NAVY SYMBOL TUBE MT. NO.2	2GA26	2GA24	2GA25	2GAA20	2GA20	2GA21	2GA23	2GA22	1GA21	1GA23	1GA22	1GAA20	1GA20	1GAAL23	1GAL20A

FOR WIRING DIAGRAM SEE ORD. DR. 230446

Figure 80-Torpedo Course Indicator Mk 1 Mods 2 (later design) and 4-wiring diagram.

therefore do not have an illumination transformer.

An explanation is given on the diagram of the particular wiring differences between the Mod 4 and Mods 0, 1, and 3.

Torpedo Course Attachment Mk I and Mods

The torpedo course attachment mechanically connects the gyro setting mechanism of the torpedo tubes to the torpedo course indicator and the latter to the indicator training rack on the tube

A reticle (crossline plate).
Eyepiece (field lens and eye lens).

Objective Window. This window is mounted in the telescope body, and is held between lead washers or gaskets of synthetic rubber by the window retainer, which is secured with machine screws. See figure 81.

Rotatable Mirror. This mirror is fitted in its mount by carefully scraping the mirror supporting surfaces in the mount so that the silvered surface, of the

stand. See figure 6.

For complete description of the Torpedo Course Attachment Mk 1 and Mods, see OP 764, "21 in. A. W. Torpedo Tubes Mk 14, 15 and Mods".

TELESCOPE MK 50 MODS 0 AND 1

Telescope Mk 50 Mods 0 and 1 are used on Torpedo Directors Mk 27. The Telescope Mk 50 Mod 1 is similar to Telescope Mk 50 Mod 0 except that protective covers for the objective window and eyepiece have been added to the Mod 1. See figures 14 and 81.

Optical Description

These telescopes are monocular, periscopic instruments with the line of sight to the target located a few inches above the horizontal axis of the eyepiece. The line of sight to the target may be elevated or depressed 30 degrees above or below the horizontal (strictly speaking, 30 degrees above or below a line parallel to the deck), to compensate for roll of the ship, so that the target can be kept in the field of view. The optical characteristics are:

Magnification	6 diameters
Field of view	8 degrees 30'
Diameter of exit pupil	5 mm
Eye distance	31 mm

The optical system, shown in figure 14 consists of:
The objective window.
A mirror which can be rotated to elevate or depress the line of sight.
A prism.
Color filters.
The objective lens.

mirror is parallel to the axis of rotation. The mirror is held in place by retaining clips. There is a bearing shaft on either side of the mirror mount and these shafts rest in bearings machined in the telescope body casting, being held in place by cap squares. On the shaft, at the left side, is a gear which is operated by a knob through an idler gear.

Prism. The function of the prism is to reflect the rays, which enter it from above, through 90 degrees through the objective lens, onto the crossline plate into the ocular, and also to erect the image of the target, both vertically and laterally. The prism has two reflecting surfaces which intersect to form an angle of exactly 90º, and the light from the mirror is reflected from these two surfaces, and then from another surface, into the objective lens. The prism is mounted in a phosphor bronze casting, on which are two flanges by which it is secured to the body casting. The prism is held in place in its mount by retaining clips.

Color Filters. There are four filters, namely, red, yellow, light neutral and dark neutral, and also a clear opening (no filter or glass) in a mount similar in shape to a five-sided pyramid. This mount is keyed to a shaft projecting through a packing gland in the body casting, with an operating knob at the outer end.

Objective Lens. This consists of a positive lens of crown glass cemented to a negative lens of flint glass. This lens forms an image of distant targets on the crossline plate. If there were no mirror or prism in the system, this image would be inverted both vertically and laterally, but the effect of the reflections in the mirror and prism is to erect this image in both directions. This lens doublet is mounted in an

TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE) OP 1586

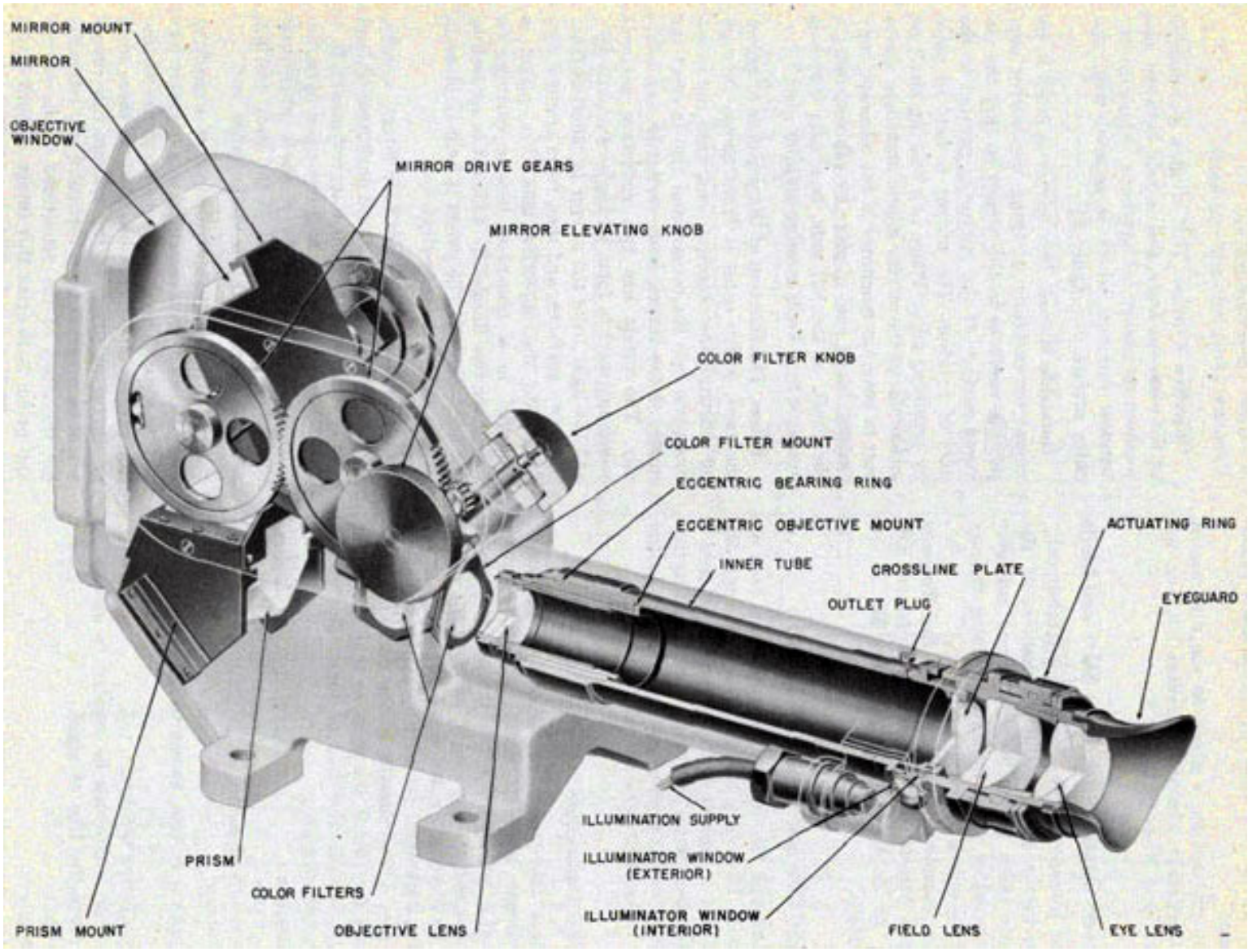


Figure 81-Cutaway view of Telescope Mk 50 Mods 0 and 1.

DESCRIPTION-FIRING KEY

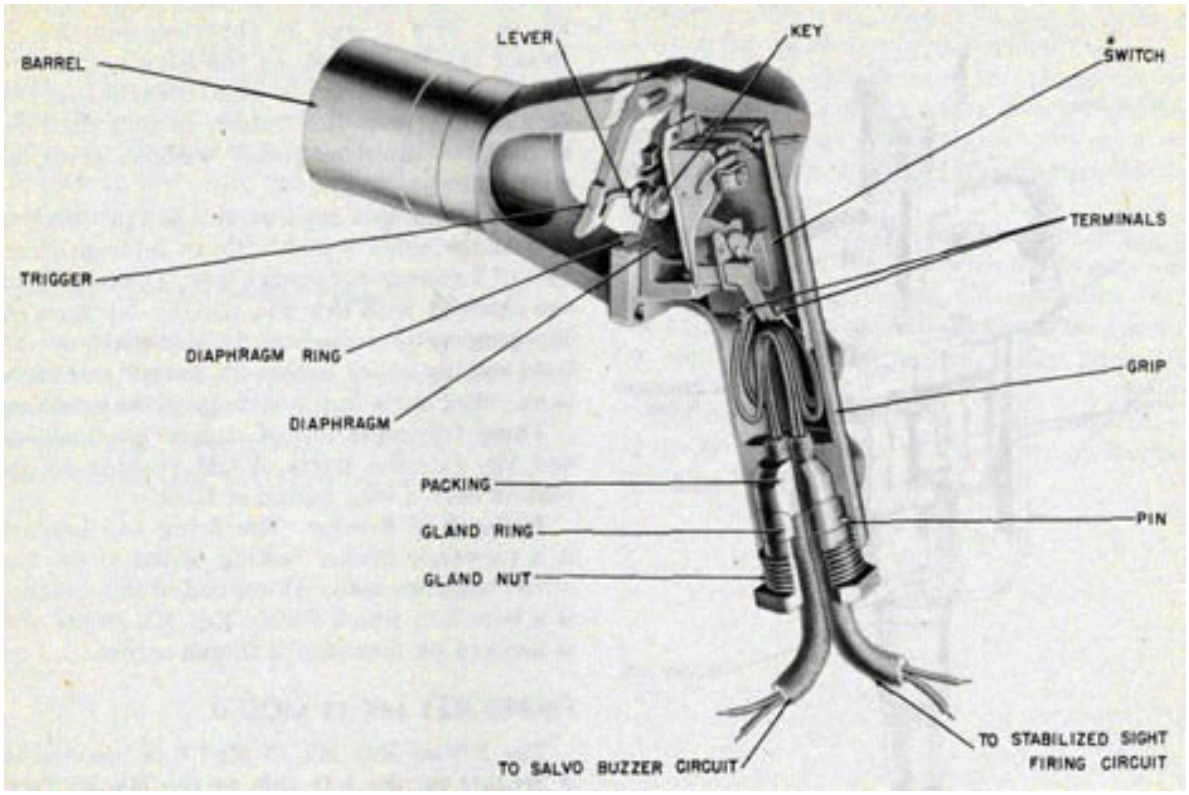


Figure 82-Cutaway of Firing Key Mk 19 Mod 0.

eccentric mount, so that the line of sight may be aligned accurately with the keyways.

Reticle (Crossline Plate). This plate is in the focal plane of the objective lens, and serves as a sealing plate for the interior of the telescope body, since the space between this plate and the eyepiece cannot be sealed tightly, due to the in-and-out movement of the latter. At night the crosslines may be illuminated by a lamp in Lamp Socket Mk 9, which is secured in a housing on the side of the telescope body tube. The light enters the telescope through a window and reaches the crossline plate through a duct.

Eyepiece. The eyepiece or ocular system consists of two cemented doublets which are mounted, and properly spaced, in the eyepiece draw tube and held in place by a retaining ring. The doublet nearer the crossline plate is known as the field lens and the doublet nearer the eye is the eye lens. The eyepiece system can be moved in or out by rotation of the focusing ring, so that it can be accurately focused on the crosslines and on the image of the target formed by the objective lens, which image lies in the same plane as the crosslines. The eyepiece may be focused from plus 2 to minus 4 diopters.

The entrant and emergent surfaces of the objective window, prism, objective lens, and both lenses of the eyepiece of some of these telescopes (those manufactured since 1942) are coated with a very thin film of magnesium fluoride in order to reduce the reflection at the surfaces and thus increase the light transmission of the telescopes. The optical surfaces in those telescopes which were completed before coating was adopted for this instrument, are being coated when the telescopes are disassembled in an optical repair shop; ultimately the optical surfaces of all telescopes in service will be coated. See OP 582 (First Revision) Chapter VIII paragraphs 33-46, for a description of this film and method of removing it.

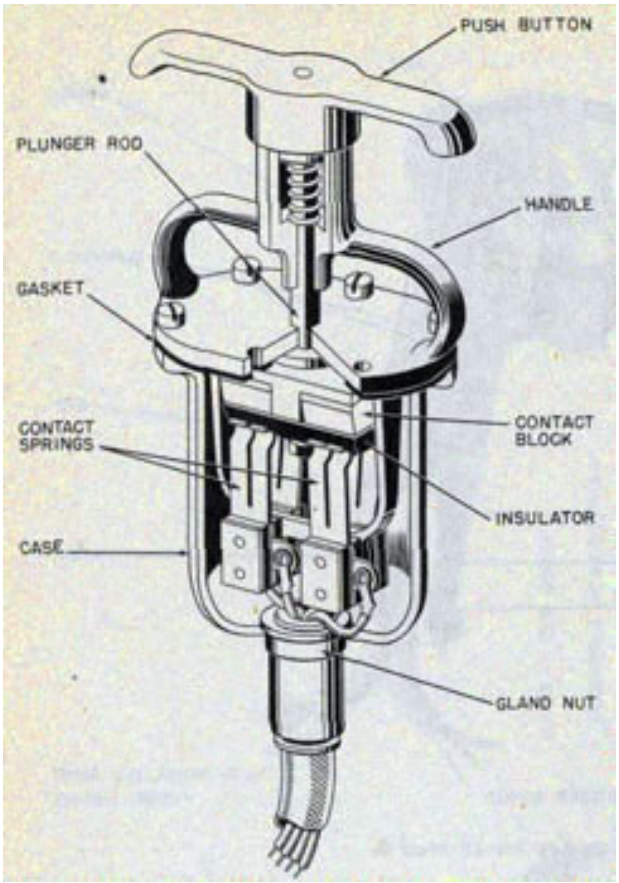


Figure 83-Cutaway of Portable Contact Maker Type M-16.

Mechanical Construction

Body. The parts described above are mounted in a phosphor bronze casting. See figure 81. There is a bore in the casting in which the inner tube fits without play, and also machined surfaces both inside and outside, for mounting the various other parts. There are four accurately machined feet, or lugs, whereby the telescope is mounted on the torpedo director.

Mounting Feet. On the bottom of the two feet on the right side of the telescope (as viewed from the eyepiece end) are accurately machined keyways which are parallel to the line of sight to the target. These keyways fit over the two parts of an interrupted key on the torpedo director so that, when the telescope is bolted in place, it is properly in the telescope feet and the keys should not be touched with a tool or abrasive, and the fit should not be altered, as the keyways in any telescope are intended to fit accurately over the keys on any torpedo director, so that the telescopes are interchangeable without error or misalignment.

These telescopes are airtight, so that there is no leakage when tested with an internal pressure of 8 pounds per square inch. The telescopes are, charged with dry gas, usually nitrogen. A charging valve is located in that part of the body casting which houses the mirror and there is an outlet valve in the vicinity of the eyepiece.

These telescopes are of rugged construction and the internal parts should require no attention over a long period of time.

Firing Key Bracket. The firing key bracket is a phosphor bronze casting bolted to the top of the telescope body. At one end of this bracket is a bore into which Firing Key Mk 19 fits and is secured by means of a thumb screw.

FIRING KEY MK 19 MOD 0

The Firing Key Mk 19 Mod 0 is inserted in a bracket on the left side of the Mk 50 Telescope. See figure 8. The bronze firing key is constructed in the form of an automatic pistol. The barrel portion of the key is inserted and fastened in the telescope mounting bracket. In place of a pistol trigger the director trainer squeezes a spring loaded key (contact maker) when he has trained the telescope crosslines on the target and is ordered to close the circuit.

A flexible leather diaphragm around the movable key prevents moisture from entering the interior. The electrical supply wires are packed as they enter

aligned and no further adjustment is necessary. The keyways and leave the key to keep the interior mechanism dry and watertight.

The firing key consists of a housing (pistol grip) which encloses the electrical switch and supports the key. Figure 82, a cutaway view of the firing key illustrates the construction of the key and the arrangement of the internal parts.

Movement of the key is transmitted by means of a lever which closes the contacts of the switch. When the key is released a spring forces the key outward and breaks the electrical contact.

Four electrical wires are connected to the switch of the firing key; two of the wires are used in the torpedo firing circuit and the remaining two are used in the ready light circuit. When the firing key is closed, both the firing circuit and the ready light circuit are closed or energized at the same time. See figure 152.

Portable Contact Maker Type M-16

The portable contact maker is used as an alternate method for firing the torpedo. It is connected in parallel with the firing key of the director and, when closed, energizes both the firing circuit and the ready light circuit. The cabling is sufficiently long to allow the user to cross to the other side of the bridge.

The contact maker is of the plunger type. It is mounted in a holder on the director splinter shield, inboard side. See figure 1. Figure 83 shows the appearance and construction of the contact maker.

The contact maker is operated by gripping the top section of the case with the fingers and forcing the spring loaded plunger down with the palm of the hand. The release of the tension on the plunger will automatically open the contact again.

The contact maker is under the cognizance of the Bureau of Ships and is shown on Bureau of Ships Plan No. 9-S-4835--L.

DD FC Home Page Next Part

Version 1.02, 17 Sep 05

Chapter 6

INSTALLATION

TORPEDO DIRECTOR

The location of the Torpedo Director Mk 27 Mods 1 to 9 varies on modern destroyers. The location depends upon the number of directors used on the ship. On destroyers with one torpedo director, it is located on the fore and after centerline, forward of the Gun Director Mk 37. On destroyers with two torpedo directors, one director is located on each of the port and starboard wings of the bridge.

The following procedure is recommended when installing the torpedo director aboard ship:

1. From the BuShips plans of the bridge, determine the exact location for the installation of the torpedo director.

2. Check the base ring (foundation ring welded to the deck) to see that the plane of its machined surface is parallel to the reference plane within the allowable tolerance of approximately 6 minutes of arc. Also check to see that the eight mounting holes have been properly prepared.

3. Before hoisting the torpedo director into its proper location, examine it, so that a director destined for the starboard side will not be installed on the port side or vice versa. This is done by examining the name plate or the position of the transformer switch on the stand. The transformer switch should always be on the inboard side when the torpedo director is sighting forward.

6. Pass the ship's cables through the six terminal tubes in the base of the stand.

7. Wire up the ship's wires to the terminal board as indicated on the wiring diagram, BuOrd Dwg 168050, for the Torpedo Director Mk 27 Mods 4 and 5. Navy lead designations for the various wires are listed on BuOrd Dwg 249085.

8. Seal the ship's cables in the terminal tubes in accordance with BuOrd Dwg 137593 in all six terminal tubes in the base of the director stand. See figure 66.

Initial Alignment

After the torpedo directors are installed aboard ship, they are aligned so that when the directors are pointing directly forward the true and relative target bearing dials will indicate zero degrees and when pointing aft, the dials will indicate 180º. The torpedo course check dials will also indicate zero and 180º for these conditions. The following procedure is recommended for initial alignment of the torpedo director:

1. Set all the dials of torpedo director to zero. This is done by turning the various hand cranks until the dials indicate zero.

2. On the dock and alongside of the ship, establish a fore and after line with a transit. See figure 84. The procedure involved for doing this is described in OP 762.

3. Train the torpedo director by turning the training handwheel until the line of sight of the telescope is on the sight of the transit.

4. Check the reading of the true and relative target bearing dials to see that they indicate the bearing of the transit. The

See figures 26 and 28.

Caution. Before hoisting the director from the dock or truck to the ship's bridge, make sure the hoisting sling is properly placed around the bottom of the director case. Do not attempt to hoist the director by attaching the sling to the projecting handwheels or to the telescope pivot.

4. Secure the director to the base ring on the bridge deck.

5. Remove the terminal board cover from the torpedo director stand.

INSTALLATION-DIRECTOR

With the torpedo director properly lined up, bench marks can be established which will serve as a reference for any future alignment of the director. On ships with two torpedo directors, the location of the bench mark is selected aboard ship so that it will serve for both directors, the bench mark is placed on some permanent structure which is approximately on the ship's fore and after centerline toward the after part of the ship. See figures 3 and 85. The following procedure is recommended for establishing the bench mark:

1. Pick a suitable location for the bench mark on some permanent part of the ship. This location should be toward the after part of the ship and approximately on the ship's fore and after centerline.

2. Train the starboard director until the vertical wire of the telescope sigh is on the torpedo course check dials should also indicate this bearing. If the dials are off, set them correctly by using the micrometer adjustment on the Dsk shaft.

Note: The above procedure is only used after initial installation of the torpedo director or when the bench marks are not available.

The reading obtained from steps (2) and (3) are the reference bearings for future alignment of the torpedo directors. The bench mark data is recorded on a data sheet which gives the exact bearing of the bench mark for each torpedo director. A sample data sheet is given below:

> "BENCH MARK DATA FOR TORPEDO DIRECTORS,
>
> No. 1 Torpedo Director (starboard) 190 degrees 32' Train
>
> No. 2 Torpedo Director (port) 173 degrees 13' Train
>
> The torpedo director bench mark is located on port side of the searchlight platform".

If battle damage or structural changes on the ship require the establishment of a new bench mark, the torpedo director must be first lined up using the transit and fore and after line on the deck as explained above. Then the bearing of the

bench mark. Record the reading of either the true or relative target bearing dials and transmitter check dials with all other dials at zero. These dials should indicate the same bearing.

3. Repeat step (2) above using the port torpedo director.

new bench mark must be established as described above.

After the director is installed and bench mark reference readings have been matched

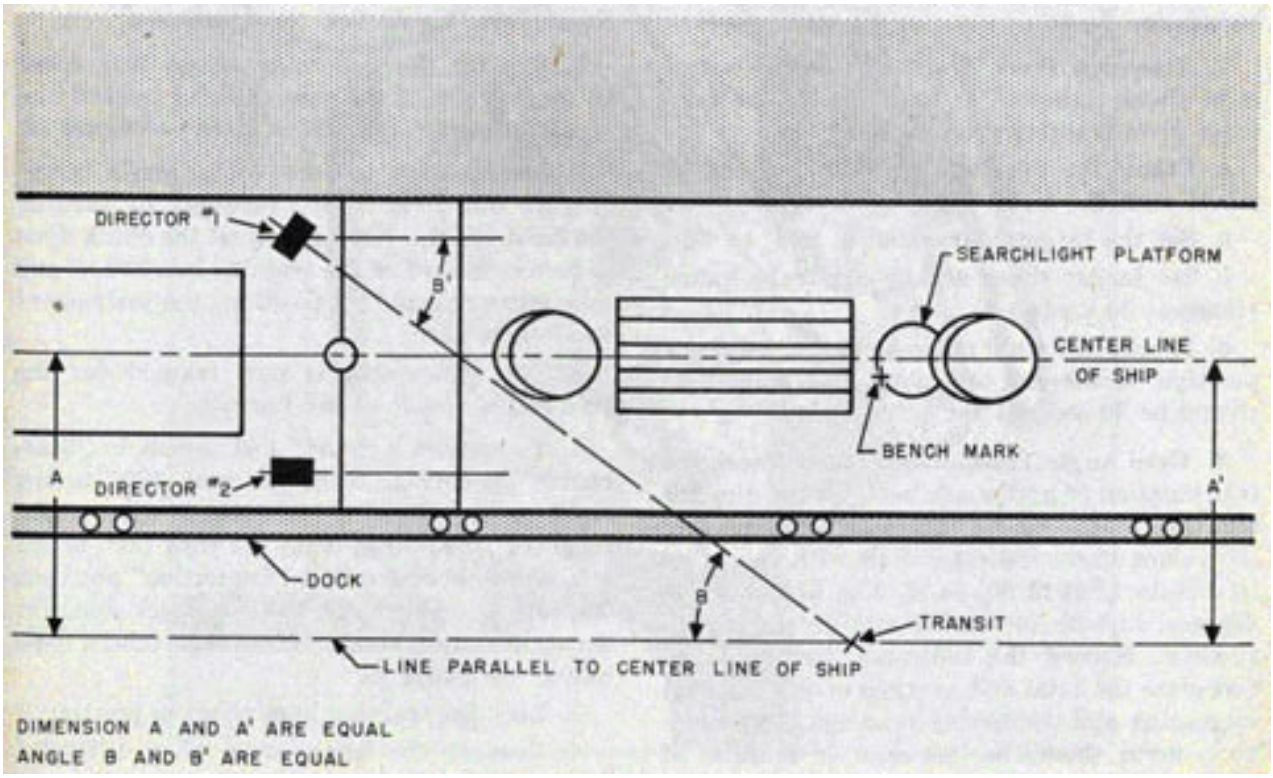


Figure 84-Diagram for director alignment and establishment of bench mark.

3. Torpedo Course Transmission Test (1- and 36-Speed): Check the transmission of torpedo course. Set in 0, 59, 118, 177, 236, 295, and 354 degrees, both increasing and decreasing. Record the indicator dial readings. Calculate the total and average errors for both increasing and decreasing. The maximum error should be less than 30 minutes.

4. Own Ship Course Receiver Transmission Test-1 Speed: Check the transmission of own ship course values between the gyro compass and the own ship course receiver unit. The maximum error should be

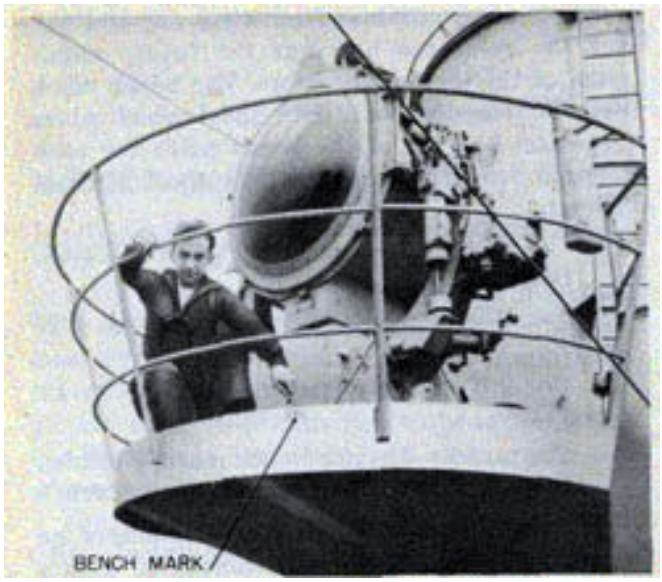


Figure 85-Typical bench mark location on searchlight platform.

with train figures given on bench mark data sheet, perform the installation tests listed in the following paragraphs.

Installation Tests

1. Telescope Pivot Training Test: This test is to check tightness or looseness of the telescope pivot training gear train.

a. Crank the telescope pivot to the end of travel with the sight angle hand crank.

b. Set the target course dial at 270 degrees or 90 degrees.

c. Set target speed at any arbitrary value. (Suggest 30 knots.)

d. Release the sight angle hand crank-check the time to the end of travel. Maximum time should be 30 seconds for a full swing.

2. Gyro Angle Transmission Test: Check the transmission of gyro angle between the director and the torpedo course indicator by comparing the values on the indicator dials with values set in less than 30 minutes.

5. Accuracy Test: By the relative bearing method of testing run the test problems 4 and 5, figures 89 and 90, using the telescope and the bearing receiver. The computed answers as read on the test indicators should not vary more than 30 minutes from the calculated answer. Own ship course input to transmitter shall be manual.

Instructions for Changing Directors to Accommodate Varying Mounting Positions (Port, Centerline, or Starboard):

1. Remove the generator access hole cover on the left side of the case (looking toward dial face) for viewing the check dials. See figure 86.

2. Set all dials to zero (outer main target bearing dial to 18 (180 degrees reading) by turning the hand cranks. Further adjust the check dials to zero by means of the training handwheel and tube offset crank. This positions the instrument to absolute zero.

3. The instrument is now trained for the zero setting made at the factory.

4. To convert a "Port" instrument to "Starboard" mounting, train the case 180 degrees to the right or to convert a "Starboard" instrument to "Port" mounting, train the case 180 degrees to the left. For conversion to a "Centerline" position, the case is trained 90 degrees. Use the check dials for accurate setting and adjust to zero (check dials only). See figure 86.

5. Lock the training handwheel in position.

6. Remove the large cover plate 168033-1 and also the small cover plate on the apron

director. Set in 90, 54, 2, 336, 310, and 284 degrees, in both increasing and decreasing directions. Record the indicator dial readings. Calculate the total and average errors for both increasing and decreasing readings. The maximum error should be less than 30 minutes of arc.

directly below to provide access to the BTO-2 shaft.

7. Remove the BTO-2 shaft and bearing bracket unit so that bevel gears disengage. Turn the bevel gear on the BTO-3 by hand until face dials are returned to the zero setting.

8. Loosen the micrometer adjustment on BTO-2 shaft and mount the shaft and bearing bracket unit in position. Readjust the check dials to zero with micrometer adjustment. Lock the adjustment.

9. To change a starboard director to port, see figure 88.

TORPEDO COURSE INDICATOR

The Torpedo Course Indicator Mk 1 Mods 0 to 4 is mounted on top of the Torpedo Course Attachment Mk 1 and Mods. The following procedure is recommended for installing the torpedo course indicator aboard ship.

1. Train the torpedo tube mount, so that the torpedo tubes are pointing directly forward, zero degrees.

2. Turn the basic gyro setting hand crank until the gyro angle output of the torpedo course attachment is zero degrees.

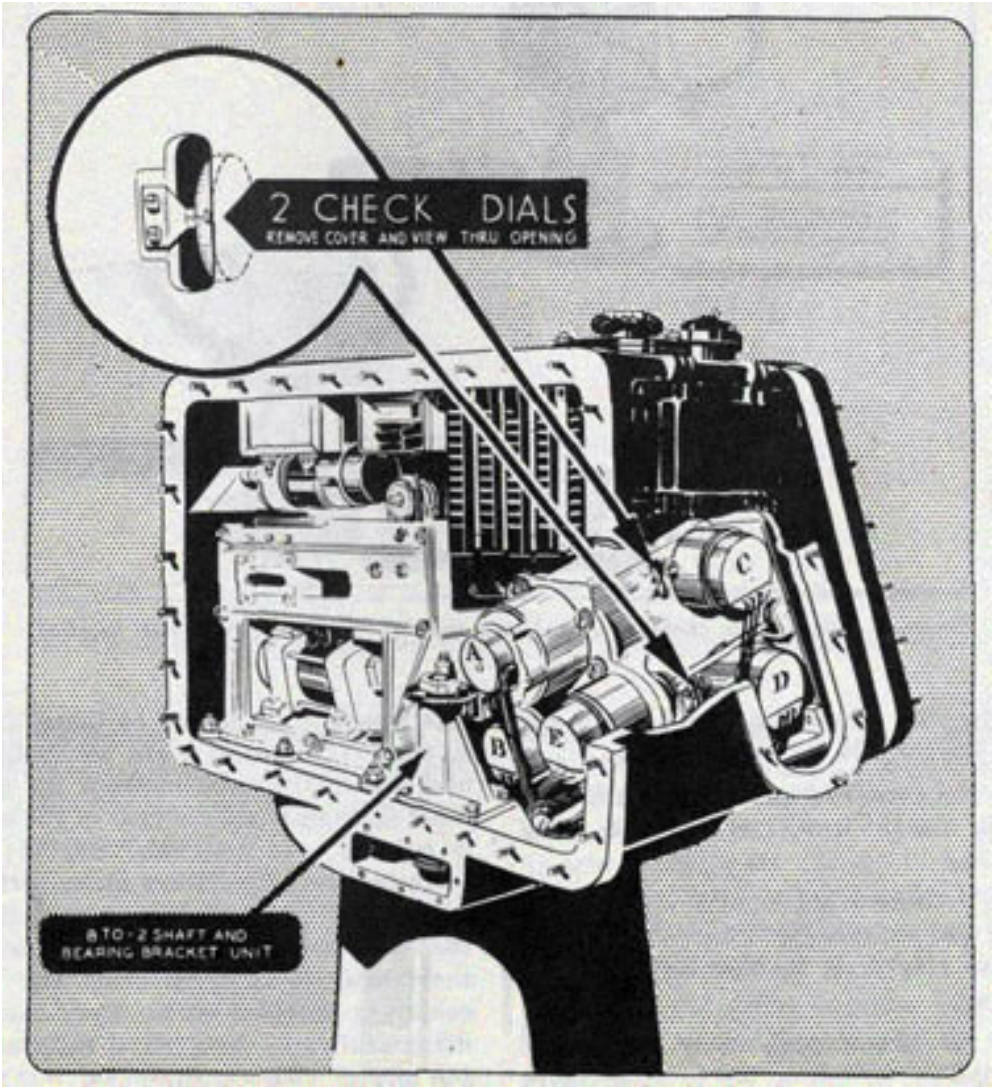


Figure 86-Diagram showing location of check dials and BTO-2 shaft in director.

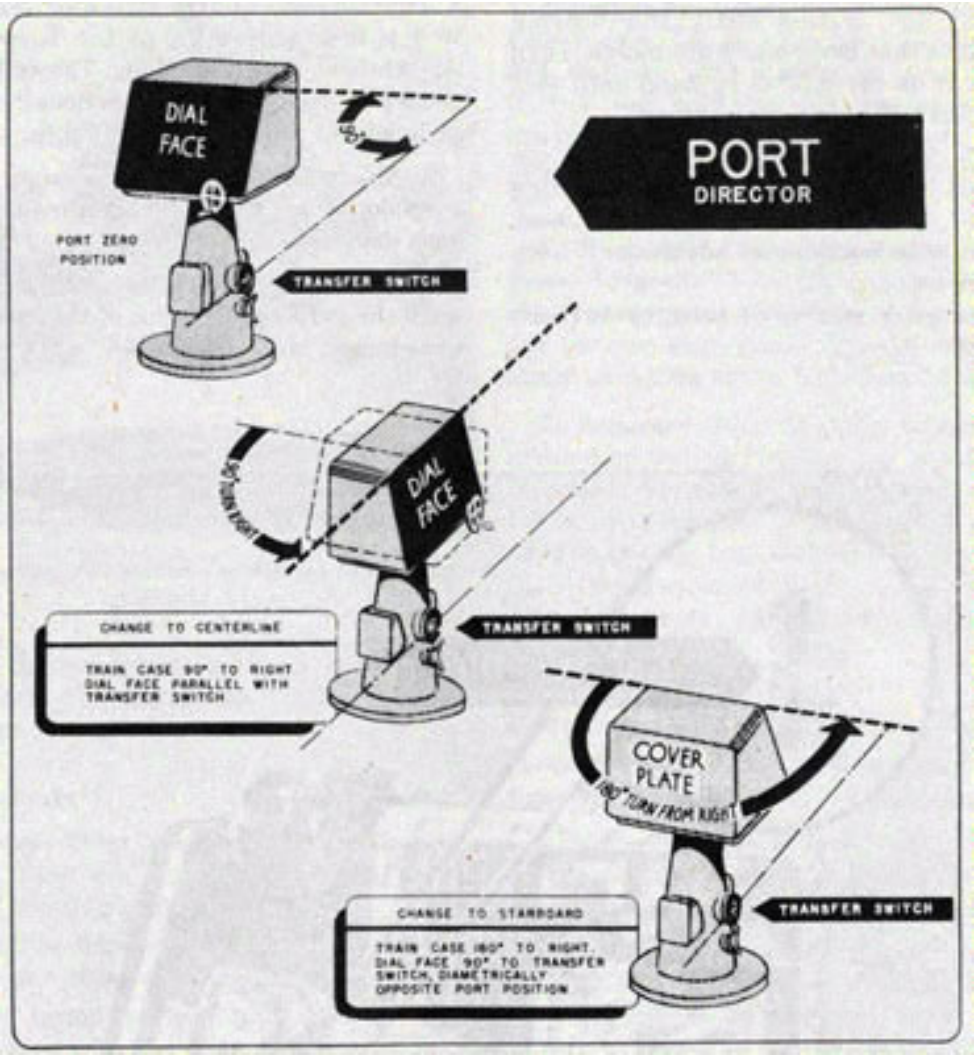


Figure 87-Diagram for changing a starboard director to a centerline or port location.

3. Remove the protecting guard from the bottom of the torpedo course indicator.

4. Turn the gyro angle input gear until the gyro angle dial indicates zero degrees gyro angle.

5. Turn the tube train input shaft until the tube train dial indicates zero degrees. The torpedo course ring dials should also indicate a zero reading.

6. With the dials at zero, mount the torpedo course indicator on top of the torpedo course attachment. Care should be taken in this step so that: (1) the dials are not disturbed, (2) backlash in the mesh between the gyro angle input spur gear and the gear of the attachment is reduced to a minimum, and (3) the tube train input shaft and key fit properly into the coupling of the torpedo course attachment. If the dials of the indicator are disturbed, bring them back to zero by using the adjustable couplings provided on the gyro angle vertical drive shaft and the vertical training shaft of the torpedo course attachment.

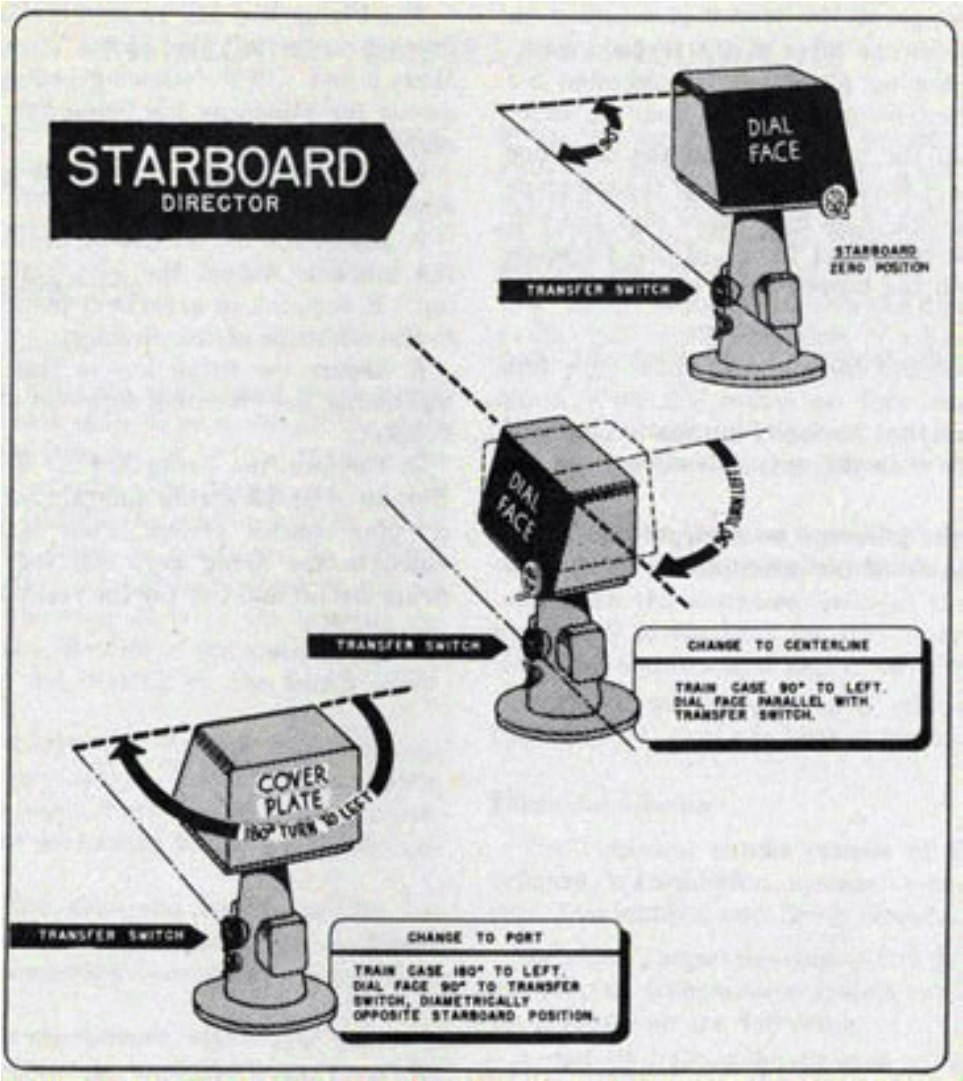


Figure 88-Diagram for changing a port director to a centerline or starboard director.

7. Secure the torpedo course indicator to the torpedo course attachment with six 5/8 in. bolts.

8. Remove the terminal board cover from the rear of the indicator case.

9. Pass the ship's electrical supply cable and the six-volt supply cable (for Mod 2 and 4 indicators only) through the terminal tubes into the instrument. Connect the electrical wires to the terminal board as indicated on the Navy Lead Designation Table provided on the inside face of the terminal board cover or by referring to the following BuOrd wiring diagrams: (1) 160933 for Torpedo Course Indicator Mk 1 Mod 0, (2) 180609 for Torpedo Course Indicator Mk 1 Mod 1, (3) 180685 for Torpedo course Indicator Mk 1 Mod 2 (original design), (4) 230446 for Torpedo Course Indicator Mk 1 Mods 2 (later design) and 4, and (5) 238028 for Torpedo Course Indicator Mk 1 Mod 3.

10. Seal the electrical cables in the terminal tubes with packing designated on the wiring diagram.

TELESCOPE MK 50 MOD 0

The Telescope Mk 50 Mod 0 is mounted on top of the telescope pivot of the torpedo director. The following procedure is suggested for attaching the telescope to the torpedo director:

1. Line up the telescope with the telescope pivot so that it fits in the groove of the telescope mounting flange. Also make sure that the bolt holes in the mounting flange of the telescope coincide with the tapped holes in the telescope pivot.

2. Fasten the telescope to the pivot with four bolts.

3. Connect the crossline illumination lamp of the telescope with the wiring leading from the pivot.

4. Sight the telescope on a target and check the illumination of the crosslines for all intensities.

FIRING KEY MK 19 MOD 0

The Firing Key Mk 19 Mod 0 is secured to a bracket on the left side of the Telescope Mk 50 Mods 0 and 1. The following procedure is suggested for attaching the firing key to the telescope bracket:

1. Loosen the clamping screw on the telescope bracket. See figure 27.

2. Insert the barrel end of the firing key in the bracket. Adjust the grip end of the key until it remains in a vertical plane in relation to the telescope of the director.

3. Secure the firing key in this position by tightening the clamping screw of the telescope bracket.

4. Connect the firing key as designated on Bureau of Ships wiring diagram for the torpedo director control system. Four leads are provided in the firing key, two for the torpedo firing circuit and two for the ready light circuit.

Chapter 7

INSTALLATION CHECKS AND ADJUSTMENTS

This chapter deals with the initial checks and adjustments necessary to put the torpedo director, telescope, firing key and torpedo course indicator in good operating condition.

TORPEDO DIRECTOR

Mechanical Checks

1. Remove the gyro angle hand crank cover and set the check dials to zero. Set all the dials of the torpedo director to "0" by turning the various hand cranks. The target course dial will now read "180". The selector switch, at the director stand, must be positioned to "OFF".

2. Rotate the training handwheel of the director until the ring dials of the bearing receiver or the middle dial of the main dial group "A" indicate the bearing of the bench mark. See figure 85.

3. Look through the director telescope and sight on the bench mark. If the telescope crossline is off the bench mark, the following adjustments must be performed to bring the telescope on:

a. Loosen the clamping screws of the micrometer adjustment on shaft Dsk 8. These screws are accessible through the fuse block opening.

b. Turn the micrometer adjustment until the telescope crossline is brought to bear on the bench mark. Check to see that the sight angle dials remain at "0".

c. With the telescope correctly set, lock the micrometer adjustment by tightening the clamping screws.

4. Turn the training handwheel and train the degrees. If the scale at the telescope does not read "0", adjust scale pointer until it is opposite the zero mark on the scale. The pointer can be adjusted by loosening clamping screws and shifting the pointer as required.

6. Turn selector switch on the director stand to the "OSC OFF" position. If all adjustments have been made correctly the telescope will not move. With the switch on this position, own ship course can be received by the one-speed synchro motor with the follow-up servo motor cut out.

7. Turn the training handwheel and check to see that the director trains easily.

8. Turn the elevating knob of the telescope and check to see that the line of sight of the telescope elevates and depresses correctly.

9. Check all the glass dial windows to see that none of them are broken or cracked.

Electrical Checks

The electrical checks consist of testing the synchro transmission system, power supply, dial illumination, and firing circuit.

Relative Target Bearing.-The relative target bearing transmission system can be checked by performing the following:

1. Set all dials of the director to "0" by turning the various hand cranks, except the target course dial which should read "180". Also, turn the selector switch to the "OFF" position.

2. Send a definite relative target bearing signal, say 38 degrees to the bearing receiver. The signal will position the inner dials of the 1- and 36-speed dial groups.

3. Turn the training handwheel and train the director

director to zero degrees relative target bearing. At this bearing, the ring dials of the bearing receiver read "0" and the middle dial of the main dial group "A" should indicate "180".

5. Check to see that the sight angle scale at the telescope agrees 'With that of the corrected sight angle dial. Both should indicate zero

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electrical zero and the inner dials set to correspond with the zero setting. To adjust these inner dials, the following must be done:

a. Remove the front cover from the bearing receiver.

b. Using the procedure outlined in OP 1303, "United States Navy Synchros", put synchro motors on electrical zero.

c. Loosen the dial clamping screws and slip the inner dials, so that their indexes line up with the fixed indexes on the dial face plate.

d. Replace front cover of instrument.

5. Check accuracy of adjustment to the inner dials by: (1) sending another signal to the instrument, (2) turning the training handwheel until the dials are matched, and (3) comparing the reading obtained from the ring dials to see that it agrees with the transmitted signal. If the reading is still incorrect, further adjustment to the inner dials is necessary.

Own Ship Course.-This test will consist of two parts. The first part deals with the synchro until the ring dials match the inner dials.

4. Check the reading of the ring dials to see that they agree with the signal being received, 38 degrees. If the dials don't agree, the synchro motors that operate the inner dials have to be set on

c. Loosen the two dial clamping screws and slip the dial until its index is lined up with the fixed index on the dial face plate.

d. Lock the dial in this position by tightening the clamping screws.

6. Check accuracy of adjustment by: (1) sending another signal to the director, (2) turning the hand crank to restore the zero reader dial, and (3) comparing the reading obtained from the own ship course dial to see that it agrees with the transmitted signal. If the reading is still incorrect, further adjustment to the zero reader dial is necessary. Replace the dial window.

7. To check the operation of the own ship course follow-up mechanism the following steps must be taken:

a. Put the own ship course hand crank in the "OUT" position. With the crank in this position, the switch in the supply circuit for the servo follow-up motor is closed.

b. Turn the selector switch, mounted on the director stand to the "ON" position.

c. Send an own ship course signal to the torpedo director.

transmission system and the second part, the operation of the own ship course follow-up mechanism.

1. Turn the selector switch mounted on the director stand to "OSC OFF". This will allow the one-speed synchro motor to receive own ship course, but will cut out the servo motor and the follow-up mechanism.

2. Put the own ship course crank in the "IN" position.

3. Send an own ship course signal to the torpedo director. This will displace the own ship course zero reader dial.

4. Turn the own ship course hand crank until the own ship course zero reader dial is restored to "0".

5. Check the reading of the one-speed own ship course dial to see that it agrees with the transmitted signal. If the reading does not agree, the own ship course synchro motor must be adjusted for electrical zero. This adjustment can be performed as follows:

a. Remove the own ship course dial window from the director case.

b. Using the procedure outlined in OP 1303, put the synchro motor on electrical zero.

d. When all motion ceases, that is the own ship course zero reader dial is restored to "0", check the reading of the own ship course dial to see that it agrees with the transmitted signal. If relative target bearing set into the director is "0", the outer ring dials of the main dial groups "A" and "B" should also indicate the same value of own ship course as the transmitted signal. If the reading of the own ship course dial does not agree with the transmitted signal, the follow-up mechanism must be adjusted.

Gyro Angle.-The gyro angle transmission system can be checked as follows:

1. Turn the gyro angle crank until the gyro angle dials indicate some value, say 45 degrees.

2. At the torpedo tube mount, have the basic gyro setting crank turned until the gyro angle dials of the torpedo course indicator are matched.

3. Compare the reading of the gyro angle dial at the torpedo course indicator with the value set into the torpedo director. If the dial

reading of the torpedo course indicator does not agree, there are three possible causes: (1) the gyro angle synchro generator in the torpedo director may be off electrical zero, (2) the gyro angle dials of the torpedo director may be set incorrectly, that is, the dial is out of synchronism with the synchro generator, or (3) the gyro angle synchro motor in the torpedo course indicator may be off electrical zero. The following procedure is recommended to adjust or correct for these three conditions:

a. Turn the gyro angle crank until the gyro angle dials indicate "0".

b. At the torpedo director, check the synchro generator for electrical zero as described in OP 1303. If the synchro generator is off electrical zero, set it on electrical zero by loosening the generator clamping screws and turning the stator of the generator until electrical zero is indicated.

c. At the torpedo course indicator,, check the gyro angle synchro motor for electrical zero as described in OP 1303. With the synchro motor set on electrical zero, adjust the dial, connected to the rotor of this motor, so that its index is lined up with the fixed index on the dial face plate. This can be done by loosening the dial clamping screws and slipping the dial until its index is lined up correctly. Lock the dial in this position by tightening the clamping screws, using special tool 8-Z-940-1 which will be found in the spare parts box.

Torpedo Course. The torpedo course transmission system can be checked as follows:

1. Set all the dials of the torpedo director to zero by turning the various cranks. Make sure the tube-offset dial is set at zero.

b. The torpedo course dials of the torpedo director may be set incorrectly, that is, the dial is out of synchronism with the synchro generators.

c. The one- and 36-speed torpedo course synchro generators in the indicator may be off electrical zero.

The following procedure is recommended to adjust or correct for these three conditions:

1. Turn the training handwheel until the torpedo course dials and the check dial indicate

2. At the torpedo director, check the one- and 36-speed torpedo course synchro generators for electrical zero as described in OP 1303. If the synchro generators are off electrical zero, set them on electrical zero by loosening the clamping screws of the generators and turning the generator stators until electrical zero is obtained.

3. At the torpedo course indicators, check the one- and 36-speed torpedo course synchro motors for electrical zero as described in OP 1303. With the synchro motors set on electrical zero, adjust the dials connected to the rotors of the motors so that their index is lined up with the fixed index on the dial face plate. This can be done by loosening the dial clamping nut and slipping the dials until their index is lined up correctly. Use special tool 8-Z-940-1. Lock the dials in this position by tightening the clamping screws.

Dial Illumination. The dial illumination system can be checked by performing the following tests:

1. Turn on the lighting supply circuit to the torpedo director.

2. Open each lightwell and check to see that both lamps in each lightwell are on.

3. Turn the knob of the crossline rheostat in the direction for increasing illumination and see that the telescope crosslines are illuminated properly, that is, the

2. Turn the training handwheel until the torpedo course dials indicate some angle, say 32 degrees.

3. At the torpedo mounts, have the training hand crank turned until the one- and 36-speed torpedo course dials of the torpedo course indicator are matched. If the dial readings of the torpedo course indicator do not agree, there are three possible causes:

a. The one-and 36-speed torpedo course synchro generators in the torpedo director may be off electrical zero.

illumination should become brighter as the knob is turned to "BRIGHT".

4. Check to see that the illumination transfer switch is operating properly. This is done by throwing the switch from "TRANSFORMER"

to "BATTERY" and checking the lightwells to see that the lamps remain on.

5. In addition to the above, turn the selector switch to "ON" and check to see that the heater is operating. The heater should throw off heat when the circuit is turned on. To check this heater, the rear cover plate must be removed from the torpedo director. Open the fuse box and check to see that none of the fuses are burned out. Replace any burned out fuses.

6. Also check all wires to see that none of them are grounded or cut.

Firing Circuit. The operation of the firing key is checked by closing the key and checking to see that it completes the firing circuit.

CAUTION: Be sure that the torpedo tube does not fire unless it is intended to fire.

Final Checks

quantities are set up correctly in the director and if the director is operating properly, the values for torpedo course, basic sight angle and corrected sight angle as produced by the director should agree with the values given for these quantities in the problem. For example: Using the values given in Problem No. 4, set the following quantities into the torpedo director: (1) 110 degrees own ship course, (2) 200 degrees relative target bearing, (3) 70 degrees target course, (4) 25 knots target speed, (5) 27 knots torpedo speed, (6) 40' (north) latitude correction, and (7) zero degrees for intercept offset, tube offset and gyro angle. As shown in figure 89 for this set-up, the torpedo course dials should indicate 252 degrees 39', the basic sight angle dial 53 degrees 19', and the corrected sight angle dial 52 degrees 39'.

If the torpedo director produces results that are more than 30 minutes off the calculated results, the internal mechanism should be checked and adjusted. These checks and adjustments should be performed by a maintenance man who knows the equipment and how to correct the trouble. If during any of these tests, troubles are found, refer to the Maintenance Section for possible

Before the torpedo director is put into actual operation, several torpedo control problems should be set up on the director and the results checked against calculated data for these problems. Two different torpedo control problems are given in figures 89 and 90. If the given remedies.

INSTALLATION TEST PROBLEM NO. 4

OWN SHIP'S COURSE	C_o	110°
RELATIVE TARGET BEARING	B_s	200°
TARGET COURSE TRUE	C_t	070°
TARGET SPEED	S_t	25 KNOTS
TORPEDO SPEED	S_{to}	27 KNOTS
LATITUDE CORRECTION	K_{la}	40°(N)
INTERCEPT OFF-SET	O_{st}	0°
TUBE OFF-SET	O_{tu}	0°
GYRO-ANGLE	B_{gy}	0°

$B_t = C_o + B_s - C_t + 180$

$B_t = 110 + 200 - 70 + 180 = 60°$

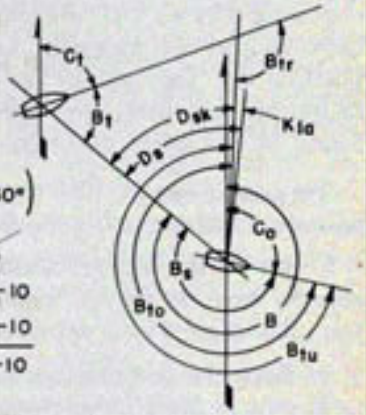
$D_s = \text{SIN}^{-1}\left(\frac{S_t}{S_{to}} \text{ SIN } B_t\right) = \text{SIN}^{-1}\left(\frac{25}{27} \text{ SIN } 60°\right)$

$S_t = 25$ lg 1.39794

$S_{to} = 27$ lg 1.43136 clg 8.56864-10

$B_t = 60°$ lg SIN 9.93753-10

$D_s = 53°19'$ lg SIN 19.90411-10



TORPEDO COURSE (B_{to}), TUBE TRAIN (B_{tu})							CALCULATED	READING	ERROR
INDICATOR	CALCULATED	INCREASING	ERROR	DECREASING	ERROR	BASIC SIGHT ANGLE (D_s)	53°19'		
FORWARD	252°39'					CORRECTED SIGHT ANGLE (D_{sk})	52°39'		
AFTER	252°39'								

Figure 89-Test problem No. 4.

INSTALLATION TEST PROBLEM NO. 5

OWN SHIP'S COURSE	C_o	110°
RELATIVE TARGET BEARING	B_s	270°
TARGET COURSE TRUE	C_t	250°
TARGET SPEED	S_t	25 KNOTS
TORPEDO SPEED	S_{to}	27 KNOTS
LATITUDE CORRECTION	K_{la}	40°(S)
INTERCEPT OFF-SET	O_{st}	0°
TUBE OFF-SET	O_{tu}	0°
GYRO-ANGLE	B_{gy}	0°

$B_t = C_o + B_s - C_t + 180$

$B_t = 110 + 270 - 250 + 180 = 310°$

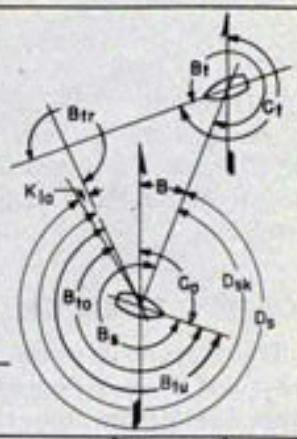
$D_s = \text{SIN}^{-1}\left(\frac{S_t}{S_{to}} \text{ SIN } B_t\right) = \text{SIN}^{-1}\left(\frac{25}{27} \text{ SIN } 310°\right)$

$S_t = 25$ lg 1.39794

$S_{to} = 27$ lg 1.43136 clg 8.56864-10

$B_t = 310°$ lg SIN 9.88425-10

$D_s = 314°49'$ lg SIN 9.85083-10



TORPEDO COURSE (B_{to}), TUBE TRAIN (B_{tu})							CALCULATED	READING	ERROR
INDICATOR	CALCULATED	INCREASING	ERROR	DECREASING	ERROR	BASIC SIGHT ANGLE (D_s)	314°49'		
FORWARD	225°29'					CORRECTED SIGHT ANGLE (D_{sk})	315°29'		
AFTER	225°29'								

Figure 90-Test problem No. 5.

TORPEDO COURSE INDICATOR

Mechanical Checks

1. Check all the glass windows to see that none of them are broken or cracked.

2. Check all the dials to see that none of them are warped or cracked.

3. Train the torpedo tube mount to see that the tube train dial and the one- and 36-speed torpedo course ring dial operates or rotates.

4. Turn the gyro angle setting crank, see that the gyro angle ring dial responds.

Electrical Checks

The electrical checks for the indicator consist of testing the operation of the synchro motors (transmission system) and dial illuminations.

Torpedo Course. Send a torpedo course signal from the director to the indicator. See that the inner dials of the one- and 36-speed torpedo course dials respond to the signal, both as to direction of rotation and amount of the rec1il signal.

The amount of the signal can be checked by training the torpedo tube mount until the dials are matched and then comparing the reading obtained from the ring dials with the transmitted signal.

Note: If during this test, the dials are found not to be operating properly, they can be adjusted using the procedure outline on page 93.

Gyro Angle. Send a gyro angle signal from the director to the indicator. See that the inner dial of the gyro angle dials responds to indicate the amount of the signal.

The amount of the signal can be checked by turning the gyro angle setting crank until the dials are matched and then comparing the reading obtained from the ring dial with the transmitted signal.

Note: If during this test, the dials are found not to be operating properly, they can be adjusted using procedure outlined on page 94.

Dial Illumination. The dial illumination system can be checked by performing the following tests:

1. Turn on the lighting supply circuit to the indicator.

2. Open each lightwell and check to see that both lamps are on.

Chapter 8

MAINTENANCE

This chapter deals with the normal maintenance required to keep the Torpedo Director Mk 27 Mods 1 to 9 and the Torpedo Course Indicator Mk 1 Mods 0 to 4 in good operating condition.

TORPEDO DIRECTOR

The torpedo director is a precision instrument and as such requires the care accorded to other similar fire control instruments.

The gears forming a part of the interior mechanism are cut with extreme accuracy and the presence of dirt, grit, and other foreign matter within the case may seriously affect, if not destroy, the effectiveness of the director. The various covers should be kept properly secured at all times, except when repairs or inspections are being made.

Cleaning

Cotton waste or other materials likely to leave threads or lint within the case should never under any circumstances be used. Cheese cloth or muslin is far more satisfactory and will eliminate a source of possible serious trouble.

Operating Hand Cranks

Undue force must never be placed upon any handwheel or crank. If an abnormal condition should exist, operation of the director should be stopped immediately and the cause ascertained and removed. Failure to heed this caution may result in serious casualties to the interior mechanism such as stripped gears or sheared pins.

Friction Adjustments

All hand cranks, except those used for training the director and the knob used for introducing latitude will occur if the interior mechanism is subjected to undue stress. The friction should be enough to operate the mechanism and no more. In no case should the moment applied exceed (30) thirty inch/ pounds in order to produce slipping.

The director is constructed almost exclusively of corrosion resisting materials, virtually eliminating troubles from corrosion. However, due to inevitable breathing of the case and stand some moisture may find its way in and result in slight corrosion of some of the parts.

Periodic Checks and Lubrication

The following check-off list gives the periodic cheeks and lubrication required which will help insure satisfactory operation of the torpedo director, telescope, and firing key.

The frequency with which these checks are made depends upon the type of service and ship board doctrine. A suggested frequency for the checks is given below.

If, when checking the instruments, any troubles are found, refer to the trouble-shooting chart, page 100, for probable causes and remedies to be used in correcting these troubles.

A. Daily

1. Energize all torpedo control circuits.

2. Check communications with tube mounts, synchro transmission of torpedo course order and gyro angle order, ready-lights, and buzzers.

3. Insure that director heater is kept energized in cold weather.

4. Clean telescope and front window with lens

correction, are provided with adjustable friction devices so designed that slip

paper. Also, clean glass windows of director if necessary.

5. Check firing circuits. This may be done by opening the torpedo tube breech door and connecting a test lamp between the firing pin and ground.

B. Weekly

1. Replenish torpedo director grease fittings (seven) with bearing grease, specification 14 G 10 (Ord).

2. Check ship's 6-volt battery supply.

3. Train director on bench mark and check to see that target bearing dials indicate the bench mark bearing.

C. Monthly

1. Remove the two covers on the lower part of the director case. Clean exposed gearing with a bristle fibre brush and coat lightly with bearing grease, specification 14 G 10 (Ord).

2. Lubricate all hand cranks by placing several drops of light preservative oil (NAVORD OS 1362) between knob hand crank shaft housing to prevent freezing.

3. Check dial illumination and crossline illumination. Where both battery and ship line supply are provided, check both.

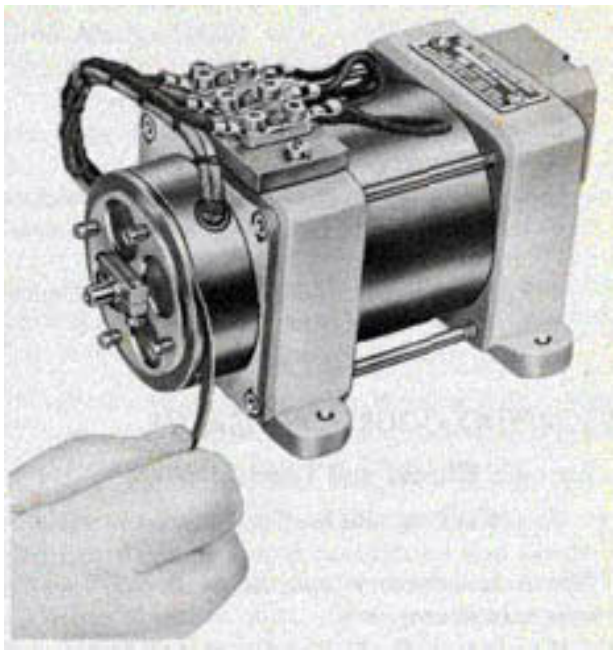


Figure 92-Checking clearance on motor damper.

4. Fill zerk fittings (2) on telescope pivot with bearing grease, specification 14 G 10 (Ord).

5. Check alignment of torpedo director. For procedure involved in performing this check, see page 86.

D. Quarterly

1. Check firing circuits electrically by firing each barrel from each director station using test lamp.

E. Annually

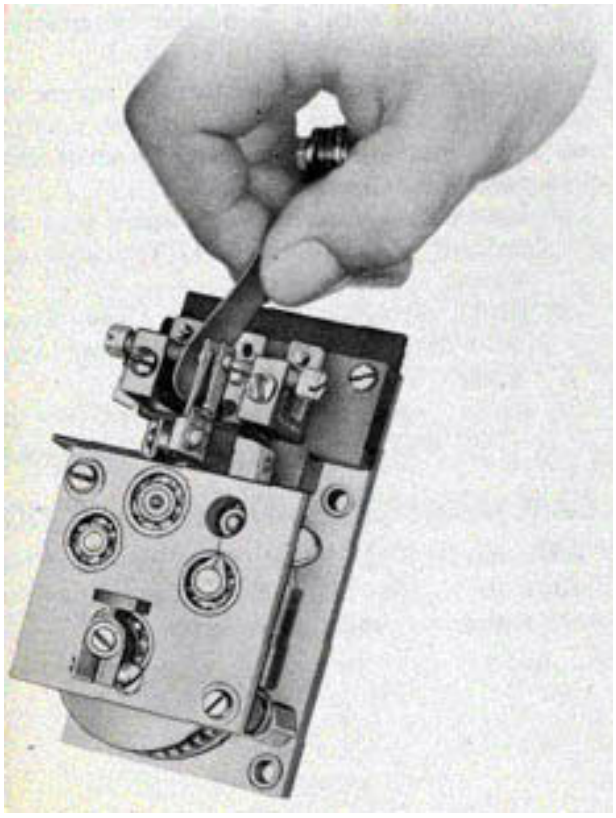


Figure 91-Measuring clearance between points of follow-up switch.

1. Remove all covers of torpedo director and inspect interior mechanism.

2. Check all electrical connections for cleanliness and tightness, covering any which become corroded frequently with a thick coat of light grease.

3. Check all contacts on follow-up mechanism, limit switch, and hand crank switches for fitting; clean and adjust as necessary.

4. Insofar as parts of torpedo director are accessible without disassembling any of the mechanism, clean with brush or lint-free cloth and lubricate as follows:

a. Lubricate all stops with vaseline (Navy Spec. 14-P-1); run traveling nut down worm or operate worm against wheel for full length; wipe off excess vaseline.

b. Brush light mineral oil on all spur and bevel gears.

c. Apply one drop of Nujol or ice-machine oil (NAVORD 05 1362) to all ball bearings.

d. Lubricate all slides and similar mechanisms with vaseline (Navy Spec. 14-P-i) and wipe off excess.

TORPEDO COURSE INDICATOR

Periodic Checks and Lubrication

4. Clean the glass windows of the instrument, if necessary.

B. Monthly

1. Check to see that none of the dials is cracked or warped.

2. Examine the glass windows to see that none of them is cracked or broken.

3. Check to see that all covers are tight.

C. Annually

1. Remove both covers of the torpedo course indicator and inspect the internal mechanism.

The following check-off list gives the periodic checks and lubrication required which will help insure satisfactory operation of the torpedo course indicator.

If, when checking the instruments, any troubles are found, refer to the Trouble Shooting Chart, page 104, for probable causes and remedies to be used in correcting these troubles.

A. Daily

1. Energize the circuits to the instrument. Check to see that the dials are illuminated properly.

2. Send a torpedo course signal to the indicator and see that the inner dials of the torpedo course dials respond to the signal. Train the torpedo tube mount and see that ring dials respond to match the signal.

3. Send a gyro angle signal from the director to the indicator and see that the gyro angle inner dial responds. Turn the gyro angle setting crank at the tube mount and see that the ring dial responds to match the signal. This test does not apply to the Mod 3 indicator, since this instrument does not have a gyro angle synchro motor.

Caution. Great care should he exercised in removing the front cover from the indicator to avoid damaging dials with projections on the cover. Thus, before removing the front cover from the indicator, first remove hack cover and then disconnect lightwell leads at the terminal boards.

2. Check all electrical connections for cleanliness and tightness, covering any which become corroded with a thin coat of bearing grease, Specification 14 G 10 (Ord).

3. Insofar as parts of the torpedo course indicator are accessible without disassembling any of the mechanism, clean with brush or lintfree cloth and lubricate as follows:

a. Lubricate all worms with worm gear lubricant (NAVORD OS 1400) ; wipe off excess.

b. Brush with light mineral oil (Navy Symbol 3050 or 2135) all spur gears and bevel gears.

c. Apply one drop of light preservative oil (NAVORD OS 1362) to all ball bearings.

CARE AND MAINTENANCE OF TELESCOPE

See chapter 8 of OP 582 (First Revision) for information and instructions regarding the care and maintenance of telescopes.

Trouble Shooting Chart

Torpedo Director Mk 27 Mods 7 to 9

Trouble	Probable Cause	Remedy
Oscillation of computer (does not stop operating)	Binding of follow-up gear train at rear of computer	Indicate all shafts to see that they are running true. Straighten bent shafts. Check to see if bearings bind. Set shafting brackets for better fit.
	Sticky reader dials	Check to see that there is three thousandths clearance between reader dials and dial shields. If dial is eccentric straighten dial shaft.
	Sticky or dirty follow-up switch points	Wash follow-up switch assembly in cleaning fluid. Sand and set switch points with a minimum clearance of 0.006 inches and a maximum clearance of 0.008 inches.
		NOTE: If above remedies do not stop oscillation try the following: a. Adjust follow-up switch damper screw upward within 0.001 inches of switch arm. Make certain the center contact barely touches left contact. This is the extreme upward screw position recommended. See figure 91. b. Adjust the sight angle motor brake to a minimum of 0.006 inches, when power is off. See figure 92.
	Worm and worm wheel on telescope pivot freezing or binding.	Disassemble and overhaul telescope pivot. Set gear and worm so worm can be turned by hand.
	Rusty bearings caused by salt water or spray penetrating case while open at sea.	Remove own ship course, computer and transmitter units from case and overhaul at shore base-or install new director.
	Too little clearance between points on follow-up switch.	Flatten and set switch points with a minimum clearance of 0.006 inches and a maximum clearance of 0.008 inches.

High problem errors	Improper zeroing of machine.	Zero machine correctly as outlined on page 102.
	Backlash of input hand cranks.	Adjust gears to take up backlash between hand crank handle and mating gear.
	Too much clearance between points on follow-up switch.	Flatten and set switch points with a minimum clearance of 0.006 inches and a maximum clearance of 0.008 inches.
	Backlash in dials and mating gears.	Reduce the clearance between mating and dial gears, to a minimum. See that they do not bind.
	Loose shaft taper pins	Use larger pins or re-ream holes.

Trouble	Probable Cause	Remedy
	Backlash or endplay in training hand crank shaft.	Place shim between hand crank and bushing.
	BTO-2 Backpost assembly backlash due to worn parts or worn gear key.	Check to see if key is tight, also that the gear does not turn on shaft. Set backpost closer to mating gear in order to remove backlash.
	Sticky dials on own ship course unit.	Re-adjust dial shield to 0.003 inches clearance between dial and shield.
	Heart-shaped cam zero out of phase with electrical zero.	Check synchro motor with standard synchro and adjust cam on shaft to proper zero by loosening friction clamp on heart-shaped cam.
	Improper spacing of points on own ship course unit follow-up switch.	Flatten and set switch points with a minimum clearance of 0.004 inches and a maximum clearance of 0.008 inches.

	Broken pig tail on own ship course unit follow-up switch	Replace and make sure new pig tail does not interfere with moving parts on director.
Director sluggish	Telescope train motor brake dragging.	Open brake to 0.012 inches maximum to allow more clearance.
	Worm and worm wheel on telescope pivot freezing or binding.	Disassemble and overhaul pivot assembly.
	Salt water in director case	Remove own ship course, computer and the transmitter assemblies from case and overhaul director at shore base or install new director.
Large error in transmission of signals between director and torpedo course indicator.	Improper zeroing of synchro motors.	Hook up synchro motor to standard synchro generator on test stand.
	Sticky bearings in synchro motors in indicator.	Remove synchro motors. Replace with new ones.
	Improper hook-up of director electrical connections to ship's wiring.	Check to see if proper connections have been made.
	Short circuits.	Check continuity of electrical circuits also check short circuits to ground with megger-if reading is less than 5 megohms remove lamps from lightwells and recheck. Continue search for shorts.

PROBABLE OPERATION DIFFICULTIES TORPEDO CONTROL SYSTEM

Trouble	Recognition	Remedy
Failure of 115-volt a-c supply.	Director fails to generate change in sight angles (telescope motion) when inputs are changed. Tubes fail to follow director.	Engage sight angle hand crank and keep zero reader dials matched. Transmit torpedo course angle and gyro angle to tubes by phone. Crank in own ship course to use true values.
Failure to receive own ship course from master gyro	Ship swings and own ship course dial does not follow.	Engage own ship course hand crank and set in own ship course by hand.
Failure of own ship course follow-up unit.	Ship swings and own ship course dial does not follow.	Engage own ship course hand crank and keep own ship course zero reader matched by hand.
Failure of sight angle motor to follow up.	Director fails to generate change in sight angle (telescope motion) when inputs are changed.	Engage sight angle hand crank and keep zero reader dials zeroed.
Failure of gyro angle order transmission.	Tubes report "Danger Bearing" and director gyro angle is not in danger bearing.	Transmit gyro angle orders by phone.
Failure of torpedo course order transmission.	Tube mount reports: "matched pointers do not check with tube mount sight."	Shift to bridge control or local aim for short range and good visibility. Transmit torpedo course order by phone for long range and poor visibility.
Damage to telescope. Remainder of director operative and target visible.	Optical and physical damage to telescope.	Get bearing from radar. Shift to bridge control or local aim and transmit sight angle to tubes by phone. Use director to compute sight angle. Keep director trained to best available target bearing.
Director completely out of commission.	Director fails to generate either electrically or manually.	Shift to bridge control or local aim; transmit data for tube sight by phone.
Failure of ready lights.	Lack of indication of annunciators.	Use phones to report "Ready", etc.

Failure of firing.	Misfire when director firing key is closed.	Fire by percussion on orders from Control.
Tube jams outside danger bearing.	Reported from tubes.	Order tubes to match torpedo course pointers by setting gyro angle as required. For torpedoes in which gyro spindles cannot be engaged; tubes report tube train angle on which jammed; director sets up problem to correspond; swing ship to bring cross-lines on and fire.

Note: Shift to local control as a last resort when all communication with tube mount is lost.

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TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE) OP 1586

Trouble Shooting Chart for Torpedo Course Indicator Mk I Mods 0 to 4

Troubles	Causes	Remedies
No dial illumination	Burned out lamps in lightwells	Inspect lamps and replace burned-out lamps
	Loose wire connections from terminal boards to lightwells	Check wire connections and tighten as necessary
Torpedo course inner dials not operating properly	Loose wire connections to torpedo course synchro motors	Check wire connections and tighten as necessary
	Synchro motors in indicator not set on electrical zero	Put synchro motors on electrical zero a described in OP 1303 "US Navy Synchros"
	Burned out synchro motors	Remove burned-out motor and replace with new one
	Dial stuck, not enough clearance between ring dial and inner dial	Remove inner dial and scrape under ring dial to make clearance
	Dials cracked or warped	Remove damaged dial and replace with new one
Gyro angle inner dial not operating properly	Loose wire connections to gyro angle synchro motor	Check wire connections and tighten as necessary

	Synchro motor not set on electrical zero	Put synchro motor on electrical zero as described in OP 1303
	Burned out gyro angle motor	Replace with new one
	Dial stuck, not enough clearance between ring dial and inner dial	Remove inner dial and scrape under rim of dial to make clearance
	Dial cracked or warped	Remove damaged dial and replace with new one
Ring dials or tube train dial not operating	Cracked dial Replace damaged dial with new one	
	Stripped gears in indicator	Open cover, inspect internal mechanism. Replace any damaged gears.
Glass windows fogged	Covers not bolted to give water-tight seal	Tighten down all covers.
	Moisture in indicator	Dry out instrument-check for rust. Make necessary repairs. Tighten down all covers.
Glass windows cracked	Uneven pressure on window retainer	Replace damaged glass and gasket with new one. Tighten down retainer evenly.
	Retainer bolted down too tightly	Replace glass and gasket and tighten retainer just enough to make water-tight seal between glass and cover.

Previous Part DD FC Home Page Next Part

Chapter 9

REPLACEMENT OF ELECTRICAL UNITS

Conditions Governing Replacement

The procedures outlined below can best be performed if the ship is in a protected harbor. However, do not attempt replacement at any time without covering the director or indicator to prevent entry of soot, grit, or moisture. After making replacement, subject installation should be checked at shore base or tender as soon as possible. **Director must he at zero before starting replacement of electrical equipment and completely tie-energized**.

1. Sight Angle Motor (Director Case)

Remove director back cover, see figure 28; remove four screws holding motor to computer back plate. The two inner screws may be reached with a long shanked screw driver from the upper part of the computer. The inner screws can be seen after fuse box cover has been removed and fuse block dropped. See figure 93. Withdraw motor to rear, disconnect wires from small terminal block on motor. See figure 94.

If the sight angle replacement motor does not contain a magnetic brake, remove the brake from original motor and attach to replacement. See figure 34.

Remove gear from shaft on end of motor and install on replacement motor.

Replace new motor in reverse order and check for proper mesh with computer mating gear.

2. Own Ship Course Follow-up Motor (Director Case)

Remove director back cover. Remove covers from own ship course unit. Remove dials of own ship course unit. Remove dial shield of own ship course unit. Next, loosen five bolts from top of case and remove four bolts. See figure 108. Disconnect own ship course unit wires from terminal board. R1F, R2F, V1, V2, U2A, U2B, S1F, S2F, S3F. Refer to BuOrd Dwg 168050. Cut all ties necessary to free these cables.

Remove center piece of Oldham coupling which connects own ship course to computer. See figure 95.

Now take a firm grip on the unit and remove fifth bolt. Now remove unit by siding as far as possible to the right side of the director case and withdraw through rear of case. See figure 112.

Caution. Extreme care must be taken in removing unit so as not to damage computer follow-up gear and heart-shaped cam assembly.

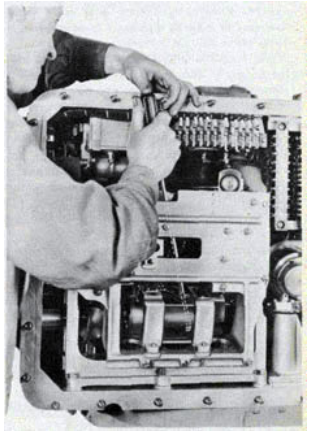

Figure 93-Removing the two inner mounting screws of the director sight angle motors with a long shanked screw driver.

Withdraw four screws securing the motor mounting clamps to chassis.,

Now, lift synchro motor from chassis. See figures 47 and 142. Remove bearing from rear of synchro motor with bearing puller.

Remove gear from front of synchro motor, use care to prevent damage. Now, remove bearing.

Install new synchro and reassemble in reverse order of outline given above.

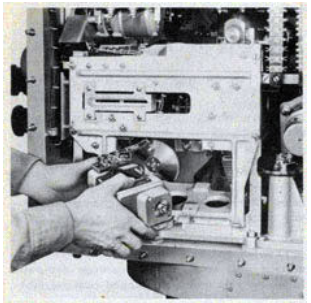

Figure 94-Withdrawing director sight angle motor from case in order to disconnect terminal wires.

Next, take the unit below decks to the machine shop.

Remove three wires from top of the motor. Withdraw four mounting screws and lift motor and damper assembly from chassis. See figures 47 and 142.

Remove flywheel damper assembly from motor by loosening clamp nut and sliding off shaft. Now, remove gear from opposite end of motor shaft.

Install new motor on chassis after attaching gear and flywheel damper.

Complete replacement by performing above steps in reverse order.

3. Own Ship Course Synchro Motor (Director Case)

Repeat all steps outlined in paragraph 2 above for withdrawing unit from case.

Remove wire cover, if necessary. Remove wires.

Remove "U" shaped frame from unit chassis and hexagon post from bearing cap.

Remove heart-shaped cam assembly by loosening clamp and sliding assembly from rotor shaft, after having first removed pigtail. See figures 44 and 142.

Check for electrical zero following procedure outlined in 0P1303. Set the roller in the heartshaped cam assembly so that zero point of the cam rollers and the synchro coincide.

4. Synchro Generators A, B, C, D, and E in Transmitter (Director Case)

A, B, and E: The removal procedure of these three generators is similar.

Figure 95-Removing center piece of director own ship course unit's Oldham coupling to computer preparatory to replacement of defective electrical part.

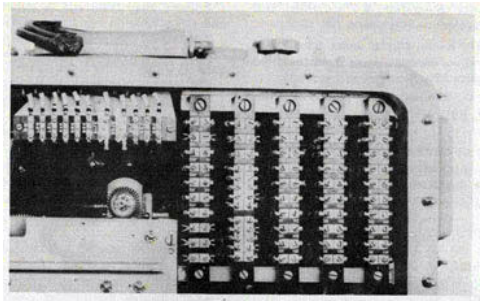

Figure 96-Numbered wiring leads on director terminal boards.

Remove back cover of director, trace wiring from synchro to be removed and disconnect from terminal board, R1A, R1B, R1E, R2A, R2B, R2E, S1A, S1B, S1E, S2A, S2B, S2E, S3A, S3B, and S3E. See figure 96.

Cut ties on tree and remove synchro wires.

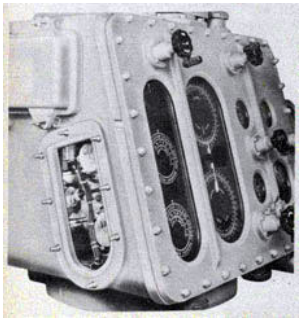

Figure 97-Gyro angle hand crank cover removed from left side of director case so that wiring leads to synchro generators C and D can be disconnected.

Loosen three clamping screws from generator and remove from chassis.

Remove gear from generator shaft.

Install gear on replacement generator.

Now install replacement generator in transmitter in reverse order. Be sure generator gear meshes correctly with mating gear.

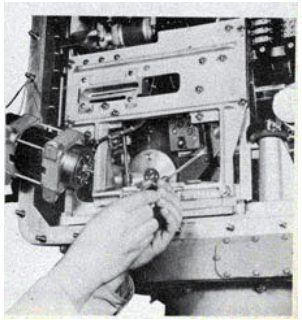

Figure 98-It is necessary to tie the director sight angle motor out of the way before removal of follow-up switch.

Check new generators for electrical zero following procedure outlined in OP 1303.

C and D: Remove gyro angle hand crank cover as well as the back cover from the director. See figure 97.

Disconnect terminals S1C, S2C, S3C, R1C, R2C, RID, R2D, S1D, S2D, and S3D. See figure 96.

Cut ties as necessary on tree to free wires.

Remove three clamping screws from generator to be removed. Lift out generator. See figure 51.

Remove gear from end of generator shaft, and reassemble on replacement generator.

Now insert replacement generator and follow above procedure in reverse order. Check gear mesh.

Check replacement generator for electrical zero following procedure outlined in OP 1303.

5. Follow-up Switch (Director Case)

Remove rear cover of director.

Remove sight angle motor following procedure outlined in section 1 of this chapter. Tie motor to one side. See figure 98.

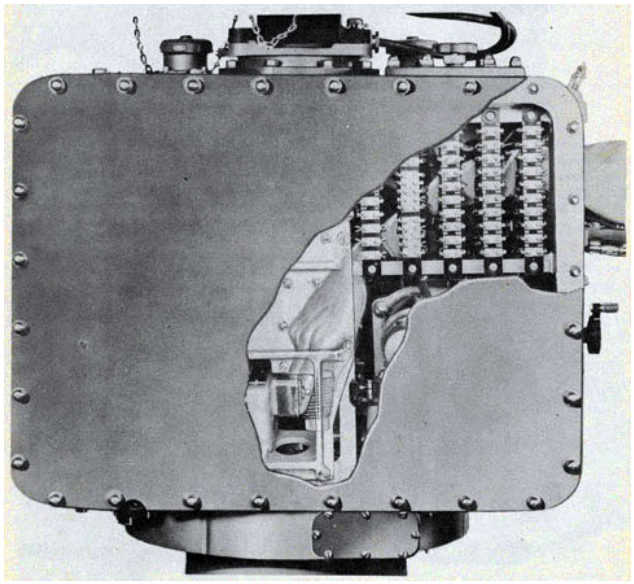

Figure 99.-Phantom view of method to be followed in order to replace defective heating unit in director case.

Remove three wires from follow-up switch.

Remove three attachment screws.

Remove follow-up switch. See figure 98.

Rotate gear in follow-up switch in counterclockwise direction until points function opposite to direction of follow-up gear rotation.

Install replacement switch on computer. Keeping points centered.

Complete installation in reverse order outlined above.

Caution. Do not train director off zero while follow-up switch is removed.

Re-zero director as outlined in Installation Checks and Adjustments, page 93 and 94.

6. Crossline Rheostat (Director Case)

Remove six cap nuts which secure rheostat to top of director case. See figure 27.

Lift out rheostat and disconnect two wire leads.

Replace with new rheostat.

7. Fuses (Director Case)

Loosen four wing nuts on fuse box cover-open box and replace defective fuses. See figure 104.

8. Heating Unit (Director Case)

Follow procedure outlined in paragraph 7. Remove six bolts holding fuse block.

Reach down through opening to base of case and unscrew defective heating element. See figure 99.

Replace.

9. Capacitor (Director Case)

Remove back cover of director.

Disconnect all capacitor wires.

Remove four screws holding capacitor.

Remove burned out capacitor.

Replace with new capacitor.

10. Terminal Board (Director Case)

Remove rear cover of director. Disconnect wiring from terminal board to be removed. Remove. two holding screws. Lift out board and replace.

11. Lightwells (Director Case)

Remove four screws mounting lightwell to case.

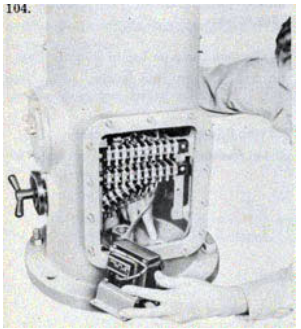

Figure 100-The director stand lower terminal block must be loosened and pushed to one side before the transformer can be removed.

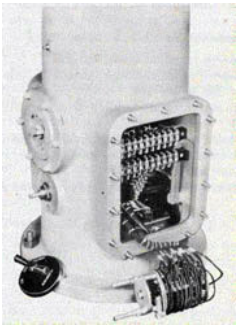

Figure 101-To replace the selector switch, remove the switch handle and cover, disconnect switch from stand, remove lowest terminal block and withdraw switch through terminal block opening.

735193-47-8

Withdraw lightwells from case and disconnect lamp wires.

Replace with new lightwell.

12. Transformer in Director Stand

Remove front and back cover plates from stand. See figure 67.

Remove screws holding the two lower terminal boards on each side of stand.

Remove four bolts holding transformer in. place and disconnect transformer wiring from terminal block.

Lift out transformer. See figure 100.

Install replacement transformer following above procedure in reverse order.

13. Terminal Boards in Director Stand

Disconnect wiring from terminal boards to be removed.

Remove two screws and replace block.

Attach wiring.

14. Transfer Switch in Director Stand

Remove six holding nuts; withdraw transfer switch. Disconnect wiring and replace.

15. Selector Switch in Director Stand

Remove terminal board covers.

Remove screw holding switch handle and cover. See figure 101.

Disconnect all switch wiring.

Install replacement switch in reverse order. See figure 69.

16. Synchro Motors-Torpedo Course Indicator

Remove back and front covers and remove indicator chassis from the case. After disconnecting wires at terminal board, remove the synchro rotor dials using special tool 8-Z-940. Release three clamping screws on defective synchro and replace with new synchro after setting on electrical zero. Refer to figure 74. See OP 1303.

Complete installation in reverse order outlined above.

17. Lightwells-Torpedo Course Indicator

Follow director procedure-see paragraph 11.

18. Terminal Boards-Torpedo Course Indicator

Remove front and back covers and chassis after disconnecting wiring.

Remove terminal board by withdrawing two holding screws.

19. Telescope Lamp on Top of Director Case

Unscrew knurled ring holding socket into lightwell. Withdraw socket and replace lamp.

20. Firing Key in Telescope Bracket

If key becomes defective replace with new key.

Remove two nuts holding selector switch to stand.

Remove two lower terminal blocks from either side of stand. The wiring, need not be disconnected.

Remove selector switch from inside of stand.

Chapter 10

DISASSEMBLY. OVERHAUL, ASSEMBLY, AND ADJUSTMENT

In listing the steps to be performed in the disassembly of the fire control system units, the common causes for mechanical failure are given, but it is impossible to detail here the exact repairs that are necessary in overhauling the units.

The overhaul of system units is usually performed after a ship's officer has reported the system is operating improperly and particular units fail to meet the required tests.

After the ship's officer has reported faulty operation, base test crews then examine the system on the ship, run four problems and if the trouble cannot be corrected, they order the removal of the faulty unit to the instrument shop for repair. Although the unit is accompanied by an inspection and test sheet a considerable amount of the operation troubles cannot be found until certain parts of the interior mechanism are disassembled and thoroughly tested.

Section 1-DISASSEMBLY AND OVERHAUL

Torpedo Director

Do not attempt to perform the disassembly by yourself. Two is the minimum number of men required for the job. No special tools are required.

Note: The removal and replacement of electrical units in the director are outlined in chapter 9.

1. Energize the director.

2. Run four problems, see figures 102 and 103 and record the results on standard test sheet.

3. Make a thorough examination of the exterior of the director. Note condition of lightwell covers, operation of hand cranks and the condition of glass windows and exposed electrical cable.

Case and Hand Crank. Figures 104 and 105.

4. Remove all hand crank assemblies by removing the screws which attach the hand cranks to the case.

5. Remove the fuse box cover on case by loosening four thumb screws.

6. Drop the fuse block by removing six machine screws.

7. Remove the gyro cover on case withdrawing eight cap nuts.

8. Remove the front cover of the case.

9. Remove the rear cover of the case by loosening and removing 28 acorn nuts.

10. Now test all electrical circuits for continuity and ground. Note all electrical failures. For replacement of electrical units follow the procedure detailed in chapter 9.

11. At this point de-energize the director before commencing further disassembly.

12. Remove window covers over own ship course dials and sight angle dials. Each cover is held by six cap nuts.

13. Disconnect all wires to the firing key. Remove the key from the telescope bracket. See figure 5.

14. Examine the leather diaphragm to see if it is watertight. Check the action of the firing key. If the operation is impaired, disassemble the key. Inspect the switch of the key for corrosion and stickiness, clean, or replace parts as necessary.

Telescope. Figures 105 and 107.

15. Remove telescope from director telescope pivot by withdrawing four mounting bolts. See figure 5. Send the telescope to the optical shop for a complete inspection.

16. Now inspect the interior mechanisms of the director for visual faults such as corrosion, dirt, fungus, and condition of the insulation on electrical wires.

VARIABLES	1	2	3	4	5
C_o	30°	240°	200°	110°	110°
C_t	340°	30°	170°	70°	250°
S_t	20K	10K	15K	25K	25K
S_{to}	27K	35K	44K	27K	27K
K_{to}	30'S	10'S	20'N	40'N	40'S
O_{si}	0	30'R	0	0	0
O_{tu}	0	20°P	1°P	2°P	2°P
B_{gy}	0	0	0	340°	45°
B_s	280°	270°	235°	200°	270°
B_t	150°	300°	85°	60°	310°
B	310°	150°	75°	310°	20°
B_{to} TRUE	302°14'	256°21'	254°31'	252°39'	225°29'
B_{to} READS					
D_s TRUE	21°44'	345°41'	19°51'	53°19'	314°49'
D_s READS					
D_{sk} TRUE	22°14'	346°21'	19°31'	52°39'	315°29'
D_{sk} READS					
B'_{tu} TRUE	302°14'	276°21'	255°31'	274°39'	182°29'
B'_{tu} READS					
B''_{tu} TRUE	302°14'	236°21'	253°31'	270°39'	178°29'
B''_{tu} READS					

Figure 102-Test problems for port director.

VARIABLES	1	2	3	4	5
C_o	30°	240°	200°	110°	110°
C_t	340°	30°	170°	70°	250°
S_t	20K	10K	15K	25K	25K
S_{to}	27K	35K	44K	27K	27K
K_{to}	30'S	10'S	20'N	40'N	40'S
O_{si}	0	30'R	0	0	0
O_{tu}	0	20°S	1°S	2°S	2°S
B_{gy}	0	0	0	340°	45°
B_s	100°	90°	50°	20°	90°
B_t	330°	120°	260°	240°	130°
B	130°	330°	250°	130°	200°
B_{to} TRUE	78°46'	104°59'	30°03'	326°01'	135°51'
B_{to} READS					
D_s TRUE	338°16'	14°19'	340°23'	306°41'	45°11'
D_s READS					
D_{sk} TRUE	338°46'	14°59'	340°03'	306°01'	45°51'
D_{sk} READS					
B'_{tu} TRUE	78°46'	84°59'	29°03'	344°01'	88°51'
B'_{tu} READS					
B''_{tu} TRUE	78°46'	124°59'	31°03'	348°01'	92°51'
B''_{tu} READS					

Figure 103-Test problems for starboard director.

Disassembly of Case and Hand Cranks.

Figure 104-Disassembly of Case and Hand Cranks.

17. Remove eight nuts which secure the telescope pivot to the case.

18. Disconnect wire terminals T1, T2, Y1, Y2, L7 and L17. Cut all ties and remove cable from harness.

19. Raise edge of telescope pivot at front of director and slide center piece of Oldham coupling 168038-6 out of coupling. This part may be withdrawn through the opening of the fuse box cover.

20. Lift telescope pivot out of case feeding cables through the computer. Place telescope pivot on bench.

23. Now examine each dial for straightness, translucency, and condition of paint. Straighten and repaint if necessary.

24. Remove all dial shields. See figure 106.

25. Loosen screws and slip out three light rods from the front of the director case. Figure 106.

26. Remove and examine own ship course dials and dial shields. Repaint or straighten as necessary. Figure 108.

27. Remove wires R1F, R2F, V2, V1, U2A, S1F, S2F, S3F, V2, U2B from terminal block in back of director. See BuOrd Dwg 168050. See figure 109.

21. Now operate the pivot by manually turning the Oldham coupling. If hand operation is impossible, overhaul pivot by performing complete disassembly and cleaning parts Reassemble, adjust worm gear, lap gears if necessary. Now test pivot action by turning Oldham coupling.

Dials.

22. Remove all dials (19) from front of director. Be careful not to scratch or deface the dials. See figure 106.

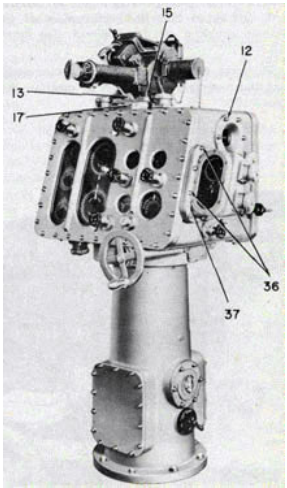

Figure 105-Removal of Telescope and Bearing Receiver.

28. Remove wires W1, W2, V10, V20, M2C, M1C from fuse block terminal. Refer to BuOrd Dwg 168050. See figure 109.

29. Remove wire terminal Bi from resistor block 180849-3. Refer to BuOrd Dwg 168050. See figure 109.

30. Remove wiring terminal M1OL, M1OR, M1R, M1L from a capacitor 170186-7. See BuOrd Dwg 168050. See figure 109.

Own Ship Course.

31. Cut all necessary ties to free these cables to the own ship course unit and the computer. Figure 109.

32. From front of director loosen clamp on own ship course unit and slip Oldham coupling down as far as possible. Jiggle own ship course unit slightly so that the center piece of the Oldham coupling can be removed. See figure 113.

33. Remove five bolts in top of director which hold the own ship course unit in position. See figure 108.

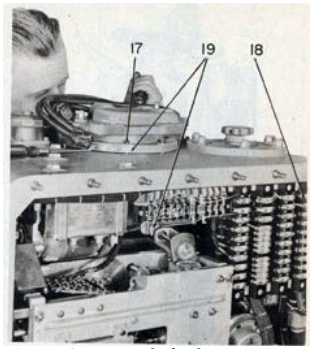

Figure 107-Removal of Telescope Pivot.

34. Now remove the own ship course unit by sliding the unit to the right side of the director case as far as possible and then slipping it out through the rear of the case. Place unit on work bench. See figure 112.

35. Now, test the operation of the own ship course unit, after replacing dials and shields, by hooking the unit to a synchro test unit and transmitting a signal. Observe results. If synchro, servo motor, or the capacitor fail to operate properly, replace them with tested assemblies in accordance with the procedure given in chapter 9. Send faulty electrical units to electrical shop.

If the heart-shaped follow-up switch does not function properly, check for burnt points, broken pig-tail wire, rusty or sticky bearings, and balance.

Caution. Care should be taken to avoid damaging the heart-shaped cam assembly on the own ship course unit.

Bearing Receiver.

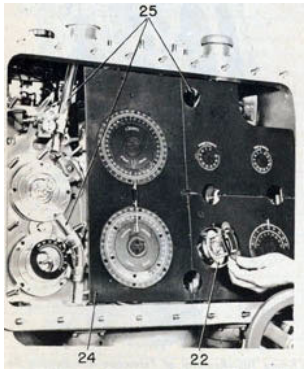

Figure 106-Removal of Dials, Shields, and Light Rods.

36. To disassemble and remove the bearing receiver, external lighting type, first remove the

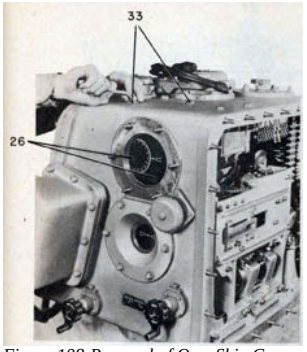

Figure 108-Removal of Own Ship Course Unit.

bearing receiver cover by withdrawing the four studs and the five bolts with cap screws. See figure 105.

37. Pry cover partially away from the case but allow it to rest on dowel pins. When cover is loose, remove wires L20 and L21 from terminal block in receiver. Now, finish removing the bearing receiver cover. See figures 105 and 110.

38. Disconnect all wiring on side of bearing receiver terminal block. See figure 110.

39. Remove the lock nuts from four stud bolts holding bearing receiver to right side of case. Figure 110.

40. Remove the bearing receiver from the director case.

41. Now, connect the complete bearing receiver assembly to a synchro test unit. Send various signals to the receiver and note results. Check for faulty synchros, grounds, condition of lightwells, and free running of dial assemblies. If synchros need to be replaced, follow procedure detailed in chapter 9.

42. To disassemble and remove the bearing receiver, internal lighting type, loosen the 12 cap nuts holding the cover. See figure 111.

43. Follow bearing receiver tree to back of the director and disconnect wiring from the director terminal boards. Figure 109.

44. Remove four bolts holding receiver chassis to case. See figure 111.

45. Remove chassis and at the same time feed the wires out through the director case and bearing receiver.

46. Check dial illumination.

47. Hook up the bearing receiver to a synchro test unit and transmit several signals. Note the results. Replace faulty synchros by following the procedure detailed in chapter 9.

48. Now, remove sight angle dial gear assembly and then drive two pins out of collar 422937- 9, at the base of the computer and slip collar as far to the left as possible. See figure 113.

49. Remove three mounting screws holding the clamp at the bottom of the external lighting type bearing receiver gear box which is attached to the right side of the computer. See figure 113.

50. Pry lower bracket loose from dowel pins and remove the gear box from computer.

51. Examine the gear box for free running of gears, corrosion and dirt. Clean, and then tag gear box with the director number.

Computer.

52. To remove the computer, start by taking off the grease cover 168081-18 on the rear of the case at training circle. Then remove the mounting screws 168076-7 which hold the stop bracket to the face of

computer. See figure 112.

53. Remove main dial group "A" gear assembly. Figure 113.

54. Remove six mounting bolts which hold the computer to the case. Be sure to mark the exact location of each of these mounting bolts as they must be inserted in their original

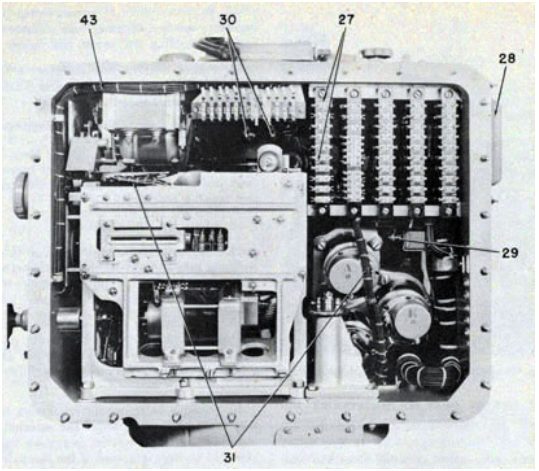

Figure 109-Removal of Wires and Terminals.

locations during the assembly procedure. See figures 112 and 113.

55. Drive the two dowel pins in front of the computer mounting pads far enough through the bottom of the case to clear the computer. See figure 113.

56. Remove bolt securing terminal bar bracket 168056-12 to computer. See figure 112.

57. Remove five screws holding terminal block to bracket and drop the bracket as much as possible. Figure 112.

58. To remove the computer from the case, tip the right-hand side of the computer upward as far as possible and slip the unit through the front of the director case. See figure 114.

Caution. In removing the computer, exercise extreme care to prevent damage to the transmitter unit gears. Place the computer assembly on the work bench.

59. Now, operate the computer assembly, manually, by turning any one of the input gears. Check for (1) excessive looseness or binding in gear trains, (2) faulty operation of follow-up switch, (3) looseness of "T" racks in guide rails, (4) excessive backlash in gear trains connecting DF6 to "T" racks, (5) binding angle solver rollers, (6) excessive end shake in angle solver guide rollers, (7) rusty bearings and dirt, etc., (8) bent shafts, (9) loose taper pins and sprung gears. If any of the above faults are observed, disassemble the computer in accordance with procedure given below.

60. **To disassemble the computer**, perform steps 61 to 73.

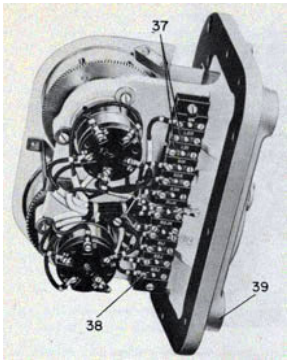

Figure 110-Removal of External Lighting Type Bearing Receiver.

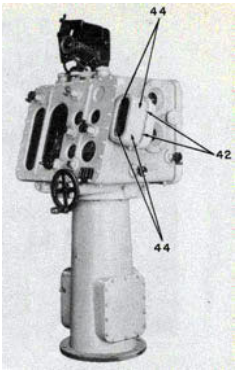

Figure 111-Removal of Internal Lighting Type Bearing Receiver.

61. Remove the two dial gear assemblies from the front plate of the computer. Inspect and clean all dial gear assemblies. See figure 113.

62. Remove the back plate assembly and the sight angle follow-up motor. Test the motor and recheck the assembly for loose taper pins and bent shafts. See figure 115.

63. Remove the follow-up switch. Check for burnt points, check condition of contact arms and pressure springs and smoothness of gear mesh. See figure 116.

64. Remove and inspect traveling nut and two intermittent gear limit stops. See figure 117.

65. Remove the front plate assembly. This operation exposes the differential gear box. See figure 117.

66. Remove the gear box. Check the differentials for free action, backlash, rusted bearings, dirt, etc. The movement of the differentials should be extremely free with an absolute minimum of backlash. See figure 119.

67. To remove the angle solvers in the computer, start with the removal of the sight angle zero-reader dial bracket. See figures 117 and 118.

68. Remove "T" racks by removing eight screws holding guide rails. Slide the guide rails out and withdraw "T" racks. See figures 118 and 119.

69. Remove plate supporting the front angle solver assembly. See figure 118. Then, check the guide rollers for free movement and fit of cam follower in cam groove. This follower should move freely along the entire length of the groove. Maximum clearance of cam in groove should not exceed 0.0005 inches. Check the action of the sliding member in the radial slot gear. It should slide freely without lost motion. See figure 120.

70. Repeat procedure in paragraph 69 for back angle solver.

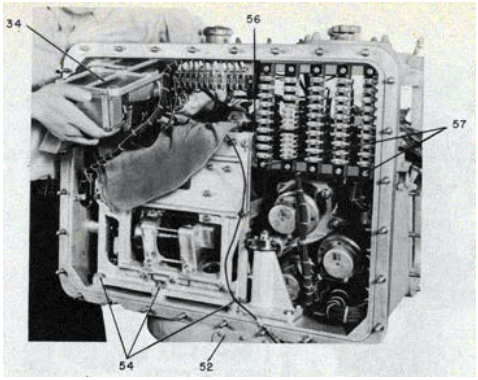

Figure 112-Removal of Own Ship Course Unit and Computer.

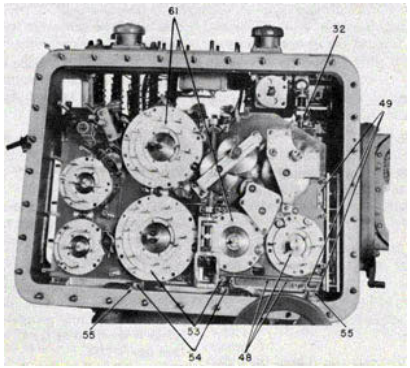

Figure 113-Removal of Computer.

71. Check the remaining computer gearing, shafting and bearings for straightness, rust, dirt, etc. Clean all parts of computer in an approved cleaning solution.

72. For Torpedo Director Mk 27 Mods 1, 2 and 3, constructed previous to Mods 4 and 5, the center mounting bolt on the rear of the computer which holds it in place is in an upside-down position. Before removing the mounting bolts it is necessary to remove the back plate assembly of the computer. See figure 115.

73. Before removing the transmitter from the case, test the synchro generators by hooking them to a synchro receiver unit. Now, crank in a position by means of the connecting gear and observe whether the output signal agrees with readings on the torpedo course and gyro angle dials.

Note: Use the check dials for accurate reading of torpedo course dials.

74. Loosen and remove the case flange nut 168019-1. See figure 121.

Transmitter.

75. To disassemble the transmitter, break and unlace all terminal connections in the director case. See figures 121 and 123.

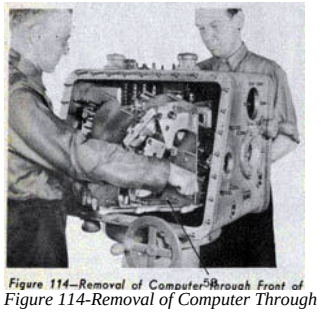

Figure 114-Removal of Computer Through Front

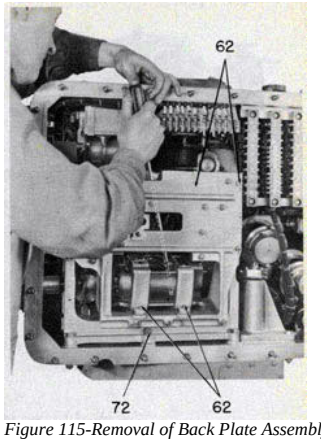

Figure 115-Removal of Back Plate Assembly.

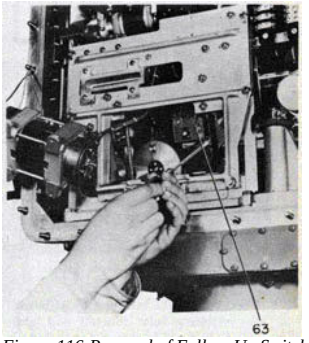

Figure 116-Removal of Follow-Up Switch.

of Case.

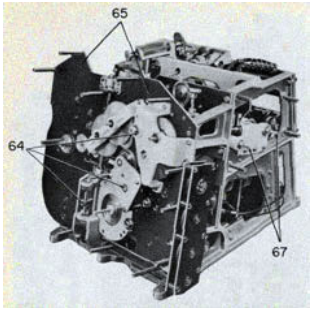

Figure 117-Steps in Disassembly of Computer.

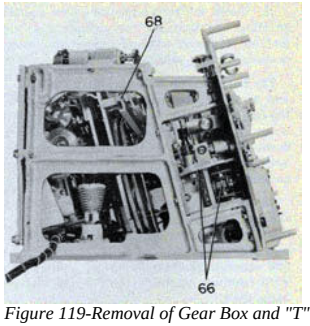

Figure 119-Removal of Gear Box and "T" Racks.

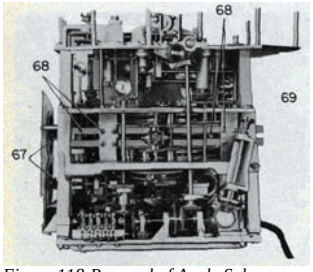

Figure 118-Removal of Angle Solvers

. 76. Then, remove the back post by withdrawing three mounting bolts. Identify and locate these bolts so they can be replaced in their original positions. Figure 121.

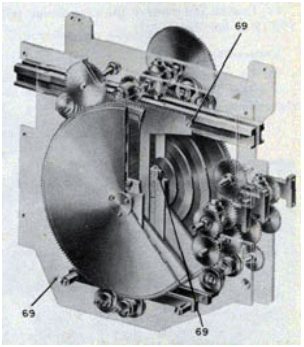

Figure 120-Removal of Supporting Plate from Front Angle Solver.

77. Now, remove the three mounting bolts holding the transmitter in the director case. Mark each bolt and its location so it can be replaced in the same location during reassembly.

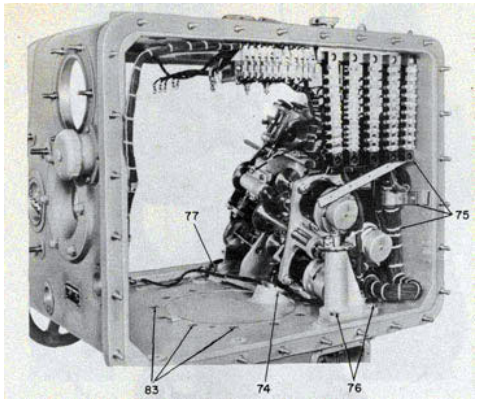

Figure 121-Removal of Back Post and Transmitter.

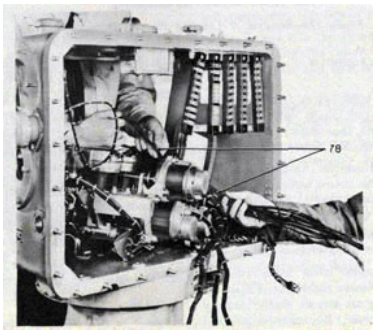

Figure 122-Loosening Main Cable Wires.

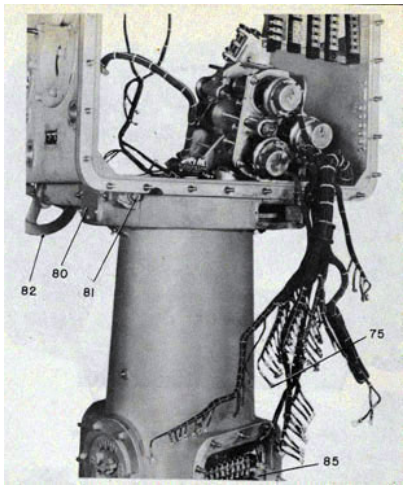

Figure 123-Removal of Locating Pin and Handwheel Shaft.

Now, tip and lay transmitter on its left side. See figure 121.

78. Loosen main cable wires from case terminal boards and pull main cables through transmitter grommets, then remove transmitter through front of case. See figure 122.

79. Place the transmitter unit on a workbench and inspect the entire assembly for free running of gears, bent shafts, damaged gear teeth, corrosion, dirt, etc. If it is necessary to remove a faulty synchro generator refer to procedure detailed in chapter 9.

80. Remove the access cover plate from inspection opening on lower right side of director case by withdrawing six screws. Drive locating pin out of worm gear. Pin can be reached through inspection opening. See figure 123.

81. Remove double nut from worm at the rear of the training handwheel shaft. See figure 123.

82. Upon completion of unpinning, remove the handwheel shaft by withdrawing it from the front. This will loosen the worm gear which should also be removed. See figure 123.

83. To remove the case from the stand; first, loosen main cable from stand terminals then, loosen and remove 12 fiat head mounting screws in the bottom of the case. See figure 121.

84. With the assistance of one other man, lift the case from the stand. See figure 124.

Stand.

85. The first step in disassembly of the director stand is to unscrew and remove the

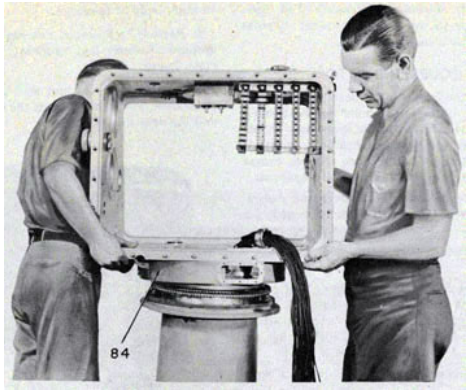

Figure 124-Lifting Case from the Stand.

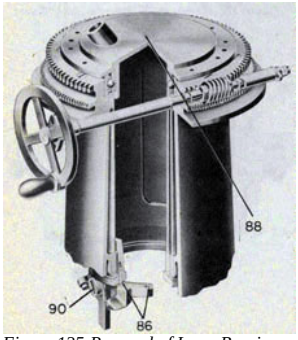

Figure 125-Removal of Inner Bearing.

terminal boards from one side of the stand. Then inspect the boards for cracks, loose terminals, corrosion, etc. See figure 123.

86. Reach into the stand and remove six flat screws holding the inner bearing plate of the training circle and stop bracket assembly. See figure 125.

87. Now inspect the felt grease seal. If worn, or damaged replace the seal.

88. Liftup and remove the inner bearing. Examine this assembly for rust or corrosion. See figure 125.

89. Inspect training circle and ball bearing for free running, chipped gears, corrosion, etc.

90. Inspect training stop assembly, examine the rubber bumpers and spring. If damaged or worn, replace. See figure 125.

91. The transfer switch and remaining terminal boards in the stand can be removed if condition warrants. If it is necessary to remove the selector switch, refer to chapter 9.

92. To complete the overhaul, clean all assemblies with Solvent-Dry Cleaning (Fed. Spec. P-S-661) or its approved equivalent. Repaint all dials with translucent paint.

TORPEDO COURSE INDICATOR

1. After the indicator has been removed from the torpedo course attachment on the torpedo tubes and transferred to the shop, tests should be run after wiring the indicator synchros to a synchro test unit. Introduce torpedo course and gyro angle orders and note discrepancies.

2. Remove indicator back cover and disconnect lightwell leads from terminal board. See figure 126.

3. Now remove the front cover. See figure 127.

gland is held in place by a pin. Remove shaft through body of telescope.

6. Remove lock screw, unscrew and remove eyepiece. Remove lens retaining ring and remove lenses.

7. Remove lock ring and with puller remove inner tube. This tube contains the objective lens and the crossline plate.

4. Inspect lightwells and wiring and condition of glass and gaskets. See figure 6. Check the condition of the dials and the paint. Check the free running of synchros by turning the inner dials slowly. See figure 127.

5. For removal of all synchros, refer to chapter 9.

6. Loosen five cap screws which secure the indicator chassis to the case. Now, remove the chassis. See figure 128.

7. Inspect the assemblies for free running of gear trains, bearings and bent shafts. Examine the mechanism for rust, dirt, etc. See figure 128.

8. Check the indicator differential assembly. If faulty, remove and make necessary repairs. See figure 128.

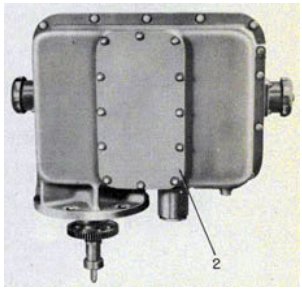

Figure 126-Removal of Indicator Back Cover.

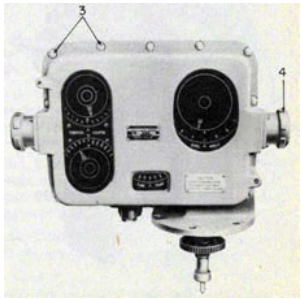

Figure 127-Removal of Indicator Front Cover.

DISASSEMBLY OF TELESCOPE

To disassemble, proceed as follows:

1. Remove objective window retainer and objective window.

2. Remove all cover plates.

3. Remove prism mount and prism.

4. Remove screws from mirror journal bearing. Remove bearings, mirror and its mount.

5. Remove color filter mount from its shaft. The shaft must be removed. Remove knob, packing gland, and packing. The collar over packing

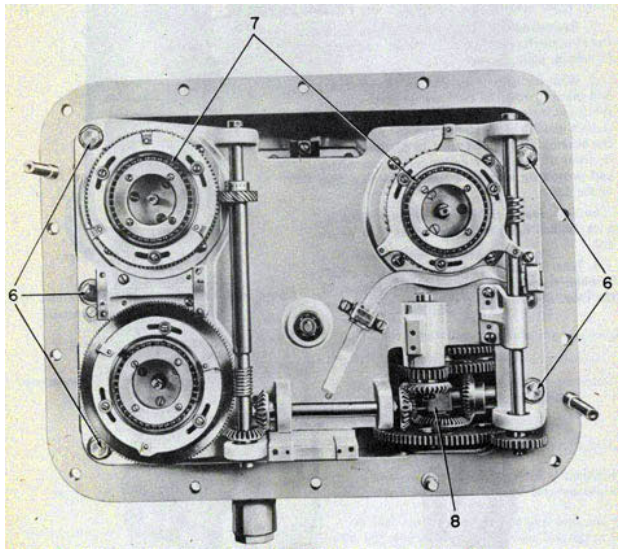

Figure 128-Removal of Chassis and Inspection of Assemblies.

Section 2-ASSEMBLY AND ADJUSTMENT

Torpedo Director

1. Take the director stand and place it on assembly platform or secure it to the floor. Be sure to fasten securely to prevent tipping after case has been attached. See figure 129.

2. Install main cable in the gland of the stand inner bearing. See figures 129 and 130.

3. Reassemble the inner bearing and training stop mechanism, place in stand, and secure to bottom plate. See figure 129.

4. With the help of another man lift the case and place it over the two dowels on the top of the stand inner bearing. The inner bearing contains a gland which extends at a 45 degree angle from the bearing. This gland must be placed directly in front of the center rectangular transmitter pad projecting above the base of the case. See figure 130.

5. Now, fasten the case to the inner bearing with 12 flat head machine screws. See figure 131.

6. Insert training handwheel and shaft through the drilled passage in the bottom of the case. Before sliding the shaft past the

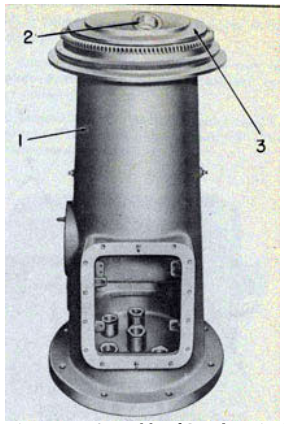

Figure 129-Assembly of Stand, Main Cable, Inner Bearing, and Training Stop Mechanism.

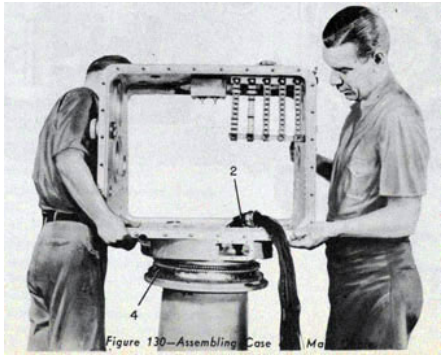

Figure 130-Assembling Case and Main Cable

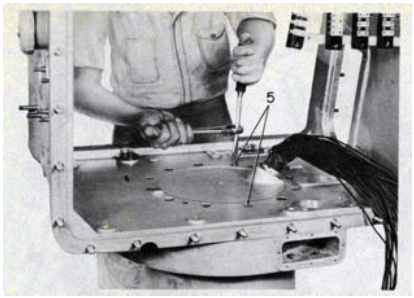

Figure 131-Fastening Case to the Inner Bearing.

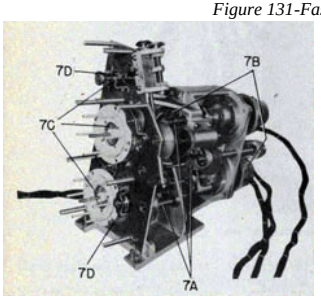

Figure 132-Assembling the Transmitter

. access opening on the right side of the case, insert the compression worm gear through the opening and slide the worm over the handwheel shaft. Drive the shaft home until it protrudes through the base of the case. Lock in place with two takeup nuts and a bushing. Adjust nuts on end of the training shaft for the compression worm so that lost motion is reduced throughout the limits of train of the director to the lowest value consistent with freedom from binding. Torque at training handwheel should be between 20 and 30 in./lbs.

Transmitter Assembly.

7. If the transmitter assembly has been dissembled for an overhaul, perform the following steps to reassemble. See figure 132.

a. Install gearing and shafting assemblies

b. Clamp synchro generators in chassis.

c. Attach dials and dial gear assemblies to the front plate of the transmitter.

d. Insert light rods and shields.

e. Attach dial shields and light reflectors.

8. Zero all synchro generators of transmitter with dials. Refer to OP 1303 for procedure.

9. Pick up the transmitter unit and place in the left side of the director case. See figure 133.

10. Place the transmitter over the two dowel pins in the front of the case.

11. Now, feed the main cable, protruding from the inner bearing gland through the two rubber grommets in the lower portion of the transmitter frame. Be sure to allow a loop in the cable where it extends beyond the back of

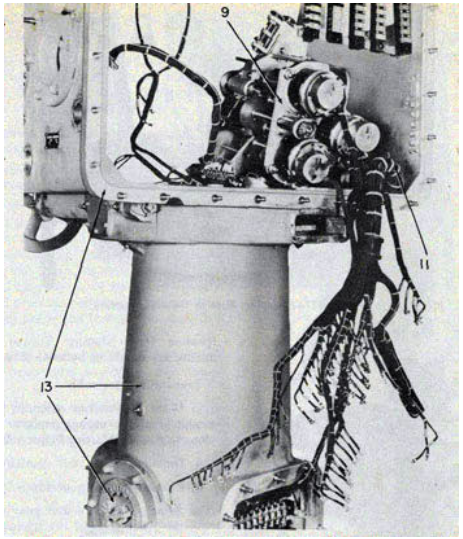

Figure 133-Replacing Transmitter and Main Cable.

the transmitter frame after slipping the rubber bushing and clamp over the cable. See figure 133.

12. Bolt the transmitter securely in place, using the four previously identified bolts.

13. Train the director so that when looking forward, the selector switch on the stand is pointing toward the left for a starboard director and toward the right for a port director. Check to see that the dial face of the case is parallel with the machined surface of the terminal board access port of the director stand. This may be accomplished by dropping a plumb bob from each corner of the case and aligning the bob cords with the machined surface of the access port. See figure 133.

Back Post.

14. Install the back post. See figure 134. Do not pull down too much on the three mounting bolts until you have made sure the beveled gear on the lower portion of the drive shaft meshes properly with the micrometer adjustment gear on the BTO-2 shaft of the back post. Be sure to place the spacer beneath back post. See figure 134.

15. Screw the resistor block in place to the lower portion of the fuse box opening. See figure 144.

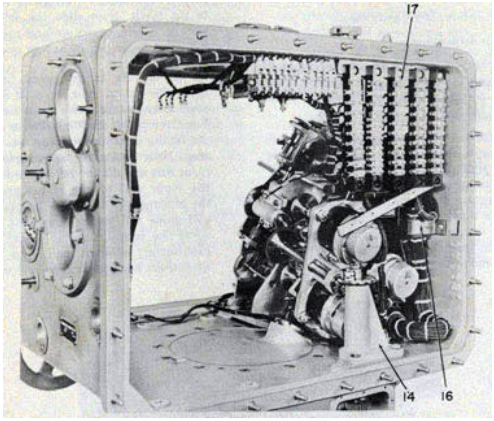

Figure 134-Installing Back Post, Main Cable, and Terminal Blocks.

16. Now, run main cable up through rubber bushing at left side of director case. See figure 134.

17. Take the five case terminal blocks and screw them in place in the upper left rear portion of the case. The terminal block nearest the center of the case bears the number U2B at the top, the adjoining has the number U2A, the following the number L17, the next number Y1 and the block nearest the left side of the case the number T1. See figure 134.

18. The clips on the ends of the wires forming the main cable are numbered. The bus bars on the terminal blocks, the resistor and the fuse box panel are also numbered. Fasten the numbered clips of the main cable wires to the proper locations on the terminal blocks, resistor and fuse panel-refer to BuOrd Dwg 168050.

Computer Assembly.

19. To assemble the computer, follow the outline below. See figures 135 to 139 and 141.

a. Secure angle solvers to front and back plates.

b. Install angle solver guide rollers.

c. Insert solver guide rails and T racks, then align guide rails with bottom and back of computer chassis.

d. Tighten guide rails to guide rail supports.

e. Install DF-4, DF-5, DF-6, and related gearing and shafting.

f. Install differential gear box containing DF-1, DF-2 and DF-3.

g. Attach limit switch.

h. Install zero reader dial assemblies.

i. Complete installation of remaining gearing and shafting.

j. Attach front plate.

k. Install intermittent gear stops.

Gear Stop Adjustments.

20. In order to obtain the proper range of speed between the extremes of the intermittent gear stops, certain adjustments must be made. See figures 140 and 141.

a. To adjust the torpedo speed limit stop, drive pin from bronze gear on end of DS-4 shaft and push the shaft assembly forward until it is disengaged from DF-5. Now rotate the back angle solver spiral gear so that the follower pin of the solver moves toward the center of the gear.

When the follower pin has reached the inner end of the spiral and the blued gauge marks of the radial gear, I rack and guide rail are in alignment, rotate the spiral gear in the opposite direction from four to six teeth. Now slide the DS-4 shaft back to original position and mesh gears. Reinstall taper pin in bronze end gear.

b. To adjust the target speed limit stop, drive pin out of gear on St-2 shaft and push gear out of mesh with St-3 shaft. Turn the St-6 shaft clockwise until the pin of the intermittent gear hits the limit stop. Now rotate the spiral gear of the front solver until the follower pin reaches the inner end of the spiral groove and the blued gauge on the radial gear, I rack and guide rail are in alignment, then reverse the rotation of the spiral gear approximately one-half inch. Now push the St-6 shaft back to its former position and

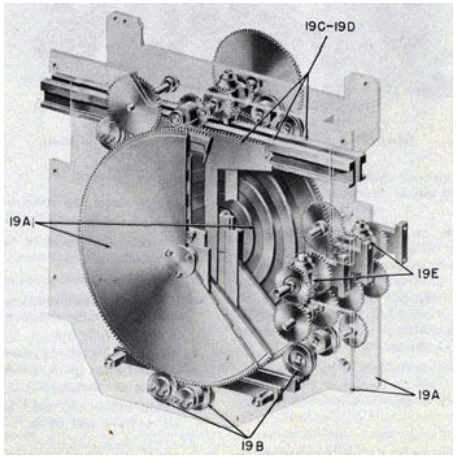

Figure 135-Computer Assembly

secure the gear in proper mesh. Replace gear taper pin.

c. To zero the computer manually, line up blued gauge marks on both solver gears, T rack and guide rail. The follower pin should be toward the bottom of the spiral groove and radial slotted gear should be pointing vertically.

d. The micrometer adjustment gear on the end of DF-6 should be set so that the adjusting screw is vertical. See that the pin on the electrical limit switch is also vertical. See figures 140 and 141.

e. Rotate the drive gear on the follow-up switch counterclockwise until the pear-shaped cam actuates the contact arm. When this switch is properly set, the contact arm will move clockwise.

f. Install follow-up switch in this position and mesh gear with driving gear in the computer.

g. Attach computer back plate.

h. Attach dial assemblies minus dials.

i. Adjust all gear meshes to a minimum backlash consistent with free running.

j. Carefully insert the computer assembly from the front of the case by slightly elevating the right-hand side. See figure 114.

Caution. Use extreme care not to damage exposed computer and transmitter gears.

21. Place computer on the two dowel pins in front of case and check to see that the connecting gears of the computer and the transmitter mesh properly.

22. Tighten six previously identified computer bolts to bottom of case. The center rear

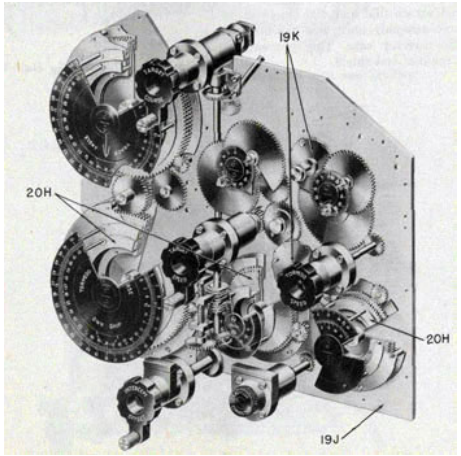

Figure 136-Installing Front Plate, Gear Stops, and Dial Assemblies.

mounting bolt should be inserted from below the case through the computer frame. See figure 141.

Own Ship Course Assembly.

23. To assemble the own ship course unit, follow the outline given below. See figure 142.

a. Assemble the worm gears and shafts in chassis,

b. Install bearings and gears on the synchro motor.

c. Clamp the synchro motor in chassis.

d. Attach the servo motor to chassis.

e. Attach the capacitor to the chassis.

f. Install the heart-shaped cam follow-up switch.

g. Mount the dial support bracket.

Note: Do not attach dial and dial shield to own ship course assembly until unit has been secured to the director case. This prevents scratching of the dial and shield.

24. From the back end of director case insert the own ship course unit. Since this unit is fastened to the top of case, it requires the services of two men to hold it in the proper position. Be sure the Oldham coupling is connected

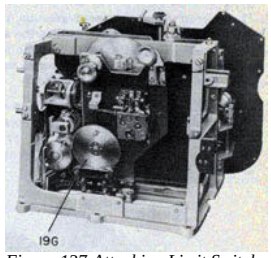

Figure 137-Attaching Limit Switch.

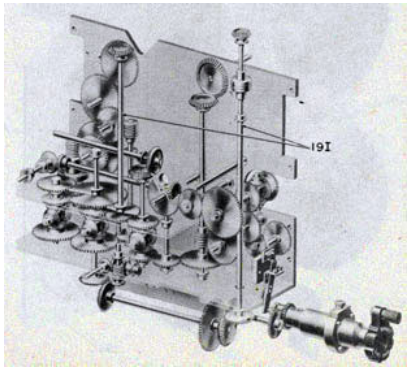

Figure 138-Installation of Gearing and Shafting.

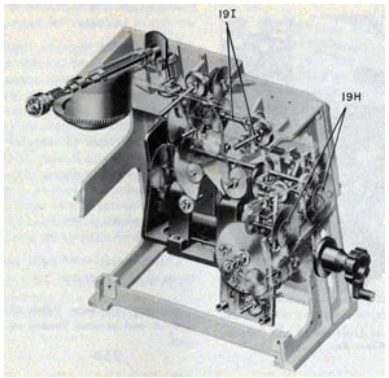

Figure 139-Installing Zero Reader Dials, Gearing, and Shafting.

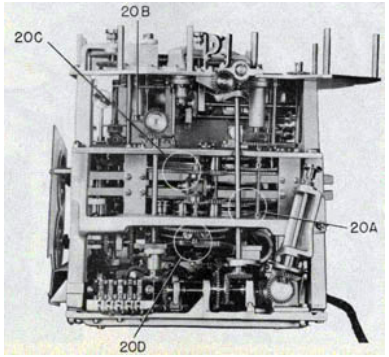

Figure 140-Gear Stop Adjustment Points.

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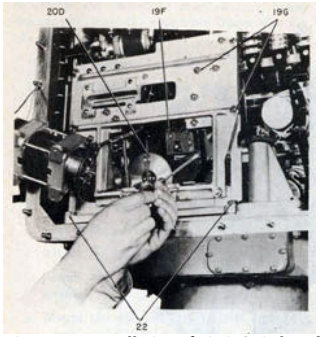

Figure 141-Installation of Limit Switch and Differential Gear Box.

properly. After the own ship course unit is in place, secure it with five bolts inserted through the top of the case. See figures 108 and 143.

To determine the time required for the own ship course receiver to reach synchronism with the synchro test unit, engage the own ship course handwheel on the director for "0 degrees" dial reading and set the synchro test unit transmitter at "180 degrees". Release own ship course handwheel on director to energize own ship course follow-up system. Repeat using 180 degrees on director own ship course dial and 0 degrees on test transmitter. Record time necessary for own ship course unit to reach synchronism with test transmitter. Maximum allowable time to reach synchronism is 28 seconds.

Check operation of sight angle cutout switch to see that it operates freely and in good order.

Caution. Be sure lightwell wires in top of case do not become fouled on own ship course unit.

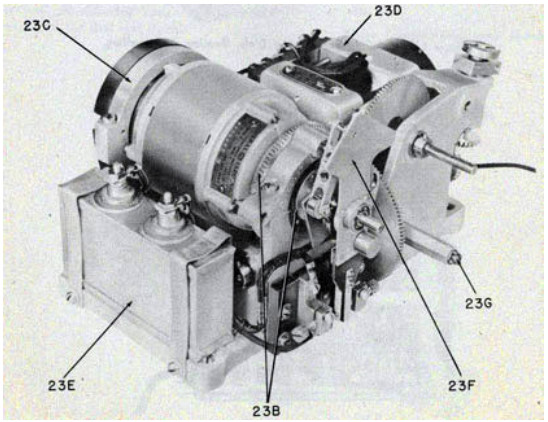

Figure 142-Assembling Own Ship Course Unit.

25. Install terminal bar bracket 168056-12 on left rear side of computer and attach to the five terminal bars recently installed.

26. Screw the clips on wires R1F, R2F, S1F, S2F, S3F, V1, V2, B1, U2A, and U2B to same numbered bus bars on terminal blocks in back of the director case. See figure 143.

27. Screw the clips on wires W1, W2, V10, V20, M2C, and M1C to similar numbered terminals on fuse block.

28. Place and secure wire numbered B1 to the resistor block.

29. Take the computer wires marked M1OL, M1OR, M1R, and M1L and attach to capacitor.

Bearing Receiver Assembly.

30. Insert the gear box for the **external lighting** gear box brackets to the front plate of the computer.

31. The two-piece shaft, at the bottom of the gear box, connecting the computer to the bearing receiver gear box should be connected as a unit by centering collar 422937-9 over the two ends. Fix the collar in place by inserting two taper pins.

32. Now install traveling nut stop bracket assembly to front plate of computer.

33. Pick up the bearing receiver connection cable and extend it through the side of the case. Slip the **external light type** bearing receiver over the four studs of the mounting pad on the right side of the case. Make sure the male end of the Oldham coupling is properly seated in the gear box. Lock in place with four elastic stop nuts.

34. Connect the bearing receiver electrical cable to the receiver terminal block.

type bearing receiver over the dowels in the computer plate and attach the upper and lower

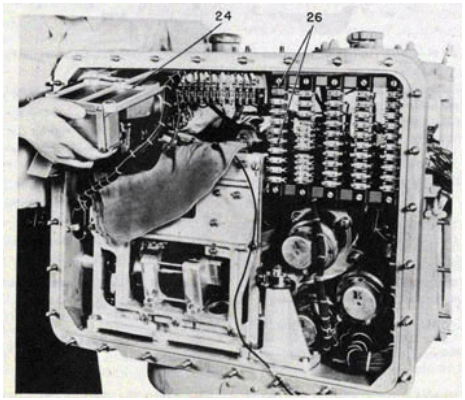

Figure 143-Replacing Own Ship Course Unit and Terminal Block Wiring.

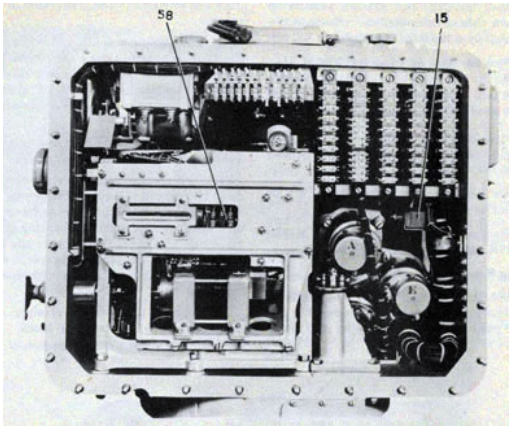

Figure 144-Check Position of Points on Follow-Up Switch. Screw Resistor Block in Place.

35. Attach the own ship course and sight angle hand cranks to the right side of the director case. Allow sufficient backlash in gears to permit engaging of hand crank without binding.

36. To install internal lighting type bearing receiver:

a. Attach receiver case to the front right side of the director case with four bolts.

b. Slip main cable through port in director case and make connection to terminal block and bearing receiver synchros.

c. Insert and connect Oldham coupling.

d. Insert receiver chassis in receiver frame and bolt in place.

Note: Do not attach cover until after zeroing receiver and computer dials.

e. Connect main cable to terminal block in back of case.

37. Replace the light rod on the front of the computer; see that end of rod is at least 3/8 inches from lightwell.

38. Center the traveling nut on the stop bracket 422933-1 between the stop nuts with the intercept offset dial at zero.

39. Install all light reflectors on dial shields. See BuOrd Dwg 251543.

40. Install dial shields in director.

41. Attach latitude correction dial, set at zero.

42. Install intercept offset dial and set dial so it will rotate in each direction the same distance without hitting stop.

43. Train the director with the handwheel until check dials of the transmitter zero

accurately. The check dials are visible through the opening for the gyro cover.

44. Lock the training wheel to maintain the transmitter at zero. (Lock with wedge.)

45. Set the computer on approximate zero by rotating the sight angle hand crank and bevel gear 168071-7 until the blued mark on the slotted gears is approximately lined up with the blued mark on the T racks, and the guide rails. Rotate the scroll gear by turning the gears counterclockwise to the stops then turn clockwise until the blued marks line up with the blued marks on the T racks and the guide rails.

46. Mount the corrected sight angle and the own ship outer ring dials on the computer at approximately zero position.

47. Install the target outer ring dial with zero on the dial to the top. This setting is approximate as final zeroing of the dials will be performed in a later operation.

Caution. Make sure 0.003-inch clearance is allowed around each dial.

48. Temporarily attach the front cover or a dummy cover to the director case. If the front cover is used, remove dial windows on the computer end.

49. Mount all hand cranks. Make hand crank friction adjustments with following torque ranges:

Gyro Angle (Bgy) 3.5 to 6.0 in./lb.
Tube Offset (Otu) 4.0 to 6.5 in./lb.
Target Course (Ct) 3.3 to 4.8 in./lb.
Target Speed (St) 3.3 to 4.8 in./lb.
Torpedo Speed (Sto) 3.75 to 6.0 in./lb.
Own Ship Course (Co) 3.5 to 6.0 in./lb.
Sight Angle (Ds) 3.5 to 6.0 in./lb.

Above torque values are applicable after installation of hand crank assemblies. Gear clutch friction should be set to 30 in./lb. Hand crank gears should not bottom or have excessive looseness, and should operate smoothly.

Zeroing the dials.

50. Accurately zero the computer by performing the following steps.

51. Install torpedo speed and target speed dials.

52. Mount intercept offset, latitude correction, torpedo speed, target speed tube offset, and target course hand cranks on the cover. Move the cranks on the mounting screws to eliminate excessive backlash between mating gears.

53. Engage the own ship course hand crank and loosen clamping screw on own ship course Oldham coupling.

54. Set check dials in transmitter on exact zero. Use a wooden wedge for locking the training handwheel.

Note: While zeroing the director dials on the computer, care should be used not to move the training handwheel.

55. Set intercept offset dial accurately on zero with the index on the dial shield by turning the intercept offset knob.

The intercept offset knob may have to be removed and the bevel gear 422947-1 slipped slightly so the knob will be in one of the detents and the dial will be on zero.

56. Check clearance between the sight angle reader dials and the dial shields. These dials must have 0.003-inch clearance between the dial shields as any binding will affect zeroing of computer.

Steps for Setting the Dials.

57. Run torpedo speed dials to the stop on the increasing side.

58. Check position of points on the follow-up switch and if points are notYen centered, rotate sight angle hand crank until points center. See figure 144.

59. Run the torpedo speed dial back to the stop on the decreasing side and watch points to see if they move. If the points move, repeat operations 57, 58 and this operation until points do not move off the center.

60. Run the target speed dial to the stop on the increasing side.

61. Check points on the follow-up switch and if the points are not centered turn the target course. hand crank until the points center.

62. Run the target speed dial back to the stop on the decreasing side. If points move, repeat operations 60, 61. and this operation until points center while running the target speed to the stop and back.

63. Slip the outer dials on the target main dial and the own ship main dial by loosening clamping rings 168072-1 and clamping screws 168070-5. (See BuOrd Dwg 168008, general arrangement.) Set the outer dial on the target main dial with the 180' mark at the index and the outer dial on the own ship main dial with zero at the index Tighten the screws 168070-5 on the clamping rings.

64. Install the inner dial assembly on the target main dial with the zero at the 180 mark of the outer ring dial.

65. Install the inner dial assembly on the own ship main dial assembly with the zero at the zero mark of the outer ring dial.

66. Set the inner dial zero of the target main dial at the 270 degree mark of the outer dial by turning the target course hand crank.

67. Check points on the follow-up switch and, if not centered, move the target speed hand crank until points center.

68. Turn the inner dial zero on the target main dial to the 90 mark on the outer dial.

69. Check the points on the follow-up switch and if not centered adjust points by turning the target speed hand crank. Repeat operations 66, 67, 68, and this operation until points hold center and the inner dial of the target main dial is at the 270 degree mark and the 90 degree mark of the outer ring dial.

70. After completing operation 69 loosen the clamping screws on target speed dial. Zero dial and tighten the clamping screws.

71. Set the inner dial of the own ship main dial at zero on the 90 degree mark of the outer ring dial by turning the sight angle hand crank.

72. Check points on the follow-up switch and if not centered move points to center by turning the torpedo speed hand crank.

73. Set the inner dial zero of the own ship main dial at the 270 degree mark of the outer ring dial by turning the sight angle hand crank.

74. Check points on follow-up switch and if not centered adjust points by turning the torpedo speed hand crank. Repeat operations 71, 72, 73, and this operation until points hold in center, with the inner dial of the own ship main dial zero at the 90 degree mark and the 270 degree mark on the outer ring dial.

75. After completing operation 74, loosen the clamping screws and zero torpedo speed dial and tighten clamping screws.

76. Turn the sight angle hand crank until the outer ring dial of the own ship main dial assembly is at zero.

77. Install the center dial 168067-4 on the target main dial with the index at zero with the pointer on the dial shield 168066-2 and clamp in place.

78. Install the center dial 168067-3 in the own ship main dial and zero pointer with pointer on the dial shield 168066-2 and clamp in place.

79. Loosen the four screws 168070-5 on the clamping ring for the dial carrier of corrected sight dial of the sight angle dial assembly. Set ring dial on zero and tighten the four clamping screws 168070-5.

80. Set basic sight angle dial 168070-6 on zero and replace clamp and clamping screws.

81. Connect terminals 43 and 44 located in the director stand to a 110-volt 60-cycle a-c supply.

82. Set selector switch to "ON" position.

83. Set transformer switch to "TRANSFORMER" position.

84. Disengage sight angle hand crank.

85. Run the torpedo speed dial to 60 knots and the target speed to 50 knots.

86. Turn the target course hand crank until the inner dial zero, of the target main dial is at 90 degrees and let director run until the computer stops.

87. Run the inner dial of the target main dial back to zero.

88. Check all dials to see if they come back to zero position: If dials do not come back to zero then an error has been made in setting the dials and must be corrected by manually zeroing the computer and resetting the dials that may be off. Operations 57 through 87 are necessary for setting the dials.

Tolerances for allowable off-set of dials with indexes are:

(1) Target speed dials shall be zeroed with the index within 0.008 inches when the target course is at 90 and 270 degrees with the follow-up points centered.

(2) The torpedo speed dial shall zero with the index within 0.008 inches when the telescope is rotated to 315 and 45 degrees with the follow-up points centered.

(3) The target course and the own ship course dials shall zero within 0.006 inches when the target speed dial is set at zero within the given tolerances.

89. Tighten clamp of Oldham coupling between the own ship course unit and the computer leaving not more than 0.008-inch lateral clearance in the coupling.

Hand Cranks.

90. Remove the target speed, torpedo speed, target course, intercept offset, latitude correction and the tube offset hand cranks from the dummy cover.

91. Remove cover from the director.

92. Touch up the screw heads and dial shields with a flat black enamel.

93. Replace the front cover 168032-1 on director and screw in place with cap nuts.

94. Replace target speed, torpedo speed, target course, latitude correction, tube offset, and the intercept offset hand cranks. Check fit between mating gears and correct if necessary.

95. Set the director dials and check dials on the transmitter at zero and install pivot with the index on the pivot at zero.

Note: The center piece of the Oldham coupling should be in position before replacing the securing nuts.

96. Replace telescope pivot wires T1, T2, Y1, Y2, L7, and L17 to the terminal blocks in the back of the director.

97. Energize the own ship course by wiring a dummy transmitter to the director. (See BuOrd Dwg 168050, wiring diagram.)

98. Set the dummy own ship course transmitter at zero.

99. Loosen the clamping screws on the heartshaped cam assembly on the own ship course unit, then hold points to either side until the inner dial on the own ship main dial approximates zero.

100. Turn selector switch to "OFF" position.

101. Tighten clamping screws on the heartshaped cam assembly, tight enough to hold on the shaft, but not so tight that tapping the clamp will not permit it to slip.

102. Turn selector switch to "ON" position.

103. Tap the clamp on the heart-shaped cam assembly until the inner dial on the own ship course dial assembly accurately zeros. -

104. Turn selector switch to "OFF" position.

105. Tighten clamping screw on the clamp for the heart-shaped cam assembly.

106. On the own ship course unit, replace the dial shield 168038-i and the light reflector 251580-1 as shown on BuOrd Dwg 251570.

107. With own ship course on electrical zero, replace the own ship course reader dial with the indexes at "0" and clamp in place.

108. Check sight angle reader dial and if not zeroed, reset by loosening clamping screws and rotate dial to "0".

109. Replace the two window covers 168032-3 over the own ship course and the sight angle reader dials.

110. Replace the front cover 168033-1.

111. Install the fuse block 168056-1 in place on the director case and screw in place with six screws 12-Z-42-30.

112. Install the fuse box cover 168055-1 by fitting the cover in place on the director and sliding the rod 168055-4 through the holes in the lugs and pinning with two cotter pins 12-Z-48-214.

113. Replace the gyro cover 168032-2.

Telescope.

114. Attach the telescope to the telescope pivot.

115. Loosen screw on adjusting clamp 422941-4. (See BuOrd Dwg 422911, general arrangement.) An access hole is provided in the chassis 422930-1 and the adjusting clamp should be held in position until after zeroing the bearing -receiver with the director. With the torpedo director zeroed, rotate the lower ring dial until both dials are zeroed with the index on the center of the dial shield. Tighten adjusting clamp.

116. With the director energized, engage the sight angle hand crank and rotate a few turns in either direction. Disengage the hand crank and allow director to zero electrically. Check dials on the bearing receiver and if they are not at zero, zero them.

117. Connect cable to bearing receiver terminal bar and transmit signal after hooking up to dummy synchro.

118. Set dummy synchro on zero and zero the inner dials of the bearing receiver to the outer dials.

119. Replace the cover on the bearing receiver and bolt in place.

120. **Zeroing Internal Lighting Type Bearing Receiver**. The 1- and 36-speed dials are set to each other and the fixed index by means of the adjustment clamp on the 48-tooth adjustable hub spur gear in the unit. This need only be done at initial assembly or if the unit is disassembled.

With the director relative bearing on zero, the bearing receiver is set to exactly zero by means of the adjustment clamp on the adjustable hub bevel gear on shaft BS5 in the director.

121. Perform electrical tests listed below.

122. Dielectric Test. For circuits which have a nominal potential of less than 25 volts, apply an alternating current potential of 115 volts between the terminals and ground. For circuits which have a nominal potential between 25 and 125 volts, apply an alternating current potential of 1,000 volts between the terminals and ground. Circuits, or groups of circuits of different voltages, shall be tested separately. The voltage shall be raised slowly to the specified value and held at that value for one minute, and then gradually reduced. The wave form of the applied voltage shall be approximately sinusoidal. There shall be no breakdown of insulation or arcing.

123. Illumination circuit at 115 volts: Turn crossline illumination rheostat to "ON" before megger test.

124. Firing key circuit-test at 115 volts.

125. Firing signal circuit-test at 115 volts.

126. Battery circuit-test at 115 volts-lamps removed from sockets. Turn battery switch to "ON".

127. Heater circuit-test at 1,000 volts-megger to ground only. Continuity between pairs of conductors.

128. Power line circuit-test at 1,000 volts.*

129. Own ship course circuit-test at 1,000 volts.*

130. Magnetic brake circuit-test at 1,000 volts.*

131. **Insulation Resistance**. Immediately after satisfactorily passing the dielectric test, each circuit shall show an insulation resistance of at least 5 megohms when a potential of 500 volts, direct current, is applied between a terminal and the ground. (This resistance test is to be run with lamps removed from sockets.)

***Close sight angle switch and own ship course switch before megger test**.

132. **Dielectric Test-Synchro System**. Apply an alternating current potential of 1,000 volts

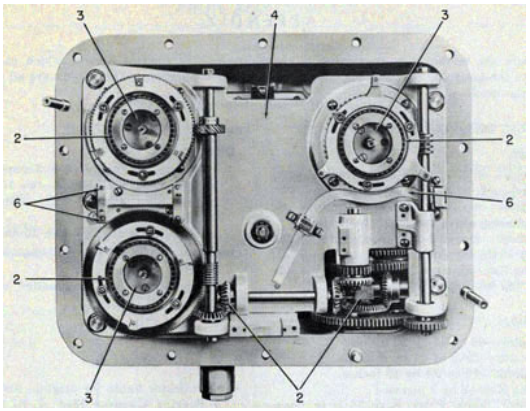

Figure 145-Assembly of Torpedo Course Indicator.

between R1 and ground, S1 and ground and between R1 and S1. Each circuit, in addition to L10 to ground and L20 to ground, shall show an insulation resistance of at least 5 megohms when a potential of 500 volts, direct current, is applied between the terminal and ground.

TORPEDO COURSE INDICATOR

See figure 145.

1. Secure indicator case and install differential.

2. Replace all dial gearing and shafting on chassis.

3. Clamp the three synchro motors in the chassis.

4. Mount the chassis in case.

5. Connect all synchro wiring to the terminal board.

6. Mount dials, dial shield, light rod, and reflectors.

7. Set zeros on dials to match indexes on dial shields.

8. Set synchro dials on zero. Refer to OP 1303 and use special tool 8-Z-940.

9. Feed lightwell wires into case and place front cover in place.

10. Secure front cover and secure lightwell wire to terminal board.

11. Replace back cover.

ASSEMBLY OF TELESCOPE

The assembly operations are performed in the reverse order of the disassembly operations.

APPENDIX

There are certain data pertaining to the Torpedo Fire Control System which cannot be placed in the foregoing chapters, but which are nonetheless important. These items are all grouped under the heading, "Appendix".

GENERAL INFORMATION

Locations

Director-on the bridge of destroyers, port, starboard, or centerline installations.
Indicator-mounted on torpedo course attachment above torpedo tube mounts.
Telescope-mounted on telescope pivot on the top of the torpedo director.
Firing Key-clamped in a bracket at the side of the telescope.

Dimensions

Director-66 by 45 by 29 inches.

Fuses

Director:

Heaters, a-c supply-two 3-amp.
Sight Angle F.U. Motor-two 1-amp.
Own Ship Course F.U. Motor-two 1-amp.
Illumination supply-two 15-amp.

Indicator (early Mod 2)-Illumination supply-one 3-amp.
Indicator (Mod 3)-Illumination supply-one 3-amp.

Signal Lights

Director:

Indicator-20 1/4 by 21 by 9 inches.
Telescope-10 by 24 by 10 inches.
Firing Key-8 by 2 inches.
Director Spare Parts Box-25 1/2 in. long, 16 1/2 in. wide, 12 1/2 in. high.

Weights

Director (without telescope or firing key)-750 lbs.
Indicator-77 lbs.
Telescope (without firing key or firing key bracket) -43 lbs.
Firing Key and Bracket-4 lbs.
Director Spare Parts-75 lbs.

Terminal Tubes

Director-refer to elementary wiring diagram.
Indicator-refer to elementary wiring diagram.

Electric Cables

Director-refer to elementary wiring diagram.
Indicator-refer to elementary wiring diagram.

Indicator lights for original design.
Bearing Receiver Mods 7, 8, 9-three Navy type VG-7.
Indicator lights for later design.
Bearing Receiver Mods 7, 8, 9-two Navy type VG-7.

Synchros

Director:

Generators-five type 5G.
Generators (Mod 2 only)-seven type 5G.
Motors-one 5B.
Motors-two 1F.

Indicator:

Motors-three type SF.
Motors (Mod 3 only) -two type 5F.

Servos (Follow-up Motor)

Director:

One 1/200 hp Type Induction Capacitor.
One 1/50 hp Type Induction Capacitor.

APPENDIX

INPUTS AND OUTPUTS

	Hand Inputs			**Electrical (Speed)**		**Mechanical Inputs**		**Usage**
	Speed	**Per Turn**	**Per Click**	**Input**	**Output**	**Speed**	**Per Turn**	
Director								
Own Ship Course	180	2º						Instead of synchro follow-up.
Sight Angle	180	2º						Instead of servo follow-up.
Target Speed		2 knots						Initial and subsequent settings.
Target Course	90	4º						Initial and subsequent settings.
Torpedo Speed		2 knots						Initial and subsequent settings.
Torpedo Course (or Relative Target Bearing):								
Mods 1,2,3,7	180	2º						Initial and subsequent settings.
Mods 4,5,8,9	120	3º						Initial and subsequent settings.

Latitude Correction	180	2º	10'					Initial and subsequent settings.
Intercept Offset	180	2º	10'					Initial and subsequent settings.
Tube Offset	180	2º						Initial and subsequent settings.
Gyro Angle Order	72	5º						Initial and subsequent settings.
Relative Target Bearing				1&36				
Own Ship Course				1				
Torpedo Course Order					1&36			
Gyro Angle Order					2			
Indicator								
Torpedo Course Order				1&36				
Gyro Angle Order				2				
Tube Train						18	20	
Gyro Angle						36	10	

TORPEDO FIRE CONTROL EQUIPMENT (DESTROYER TYPE) OP 1586

DIAL GRADUATIONS

/td>

	One turn equals	**Graduations**		**Numbered**	
		Interval	**From-To**	**Interval**	**From-To**
Director					
Main Group "A";					
Outer Ring	360º	2	0º to 360º	10º	0º to 360º.
Middle Ring	360º	2	0º to 360º	10º	0º to 360º.
Center	360º	Single index			
Main Group "B":					
Outer Ring	360º	2	0º to 360º	10º	0º to 360º.
Middle Ring	360º	2	0º to 360º	10º	0º to 360º.
Center	360º	Single index			
Target Speed	60 knots	By knot	0 to 50	5 knots	0 to 50.
Torpedo Speed					
Mods 3,4,5,6,8,9	60 knots	By knot		5 knots	
Mods 1,2,7	50 knots	By knot		5 knots.	
Latitude Correction	60º	30'		2º	0º to 4º each side of index.
Basic Sight Angle	60º	30'		2º	0º to 4º each side of index.
Tube Offset	80º	By degree		5º	0º to 30º each side of index.

Torpedo Course	360º	By degree		10º	0º to 360º.
Gyro Angle	360º	5º	From 80º 270º omitted.	20º	0º to 360º.
Own Ship Course	360º	2º		20º	0º to 360º.
Own Ship Zero Reader	360º	Single index			
High Speed Zero Reader	10º	Single index			
Low Speed Zero Reader	360º	Single index			
Relative Target Bearing:					
Low Speed	360º	5º	0º to 360º	10º	0º to 360º.
High Speed	10º	10'	0º to 10º	By degree	0º to 10º.
Check Dials	10º	10'	0º to 10º	By degree	0º to 10º.
Auxiliary Sight Angle:					
Scale	360º	By degree	From 290º through 0º to 65º.	10º	From 290º through 0º to 65º.
Indicator					
Tube Train	360º	2º	0º to 360º	10º	
Gyro Angle	180º	By degree	280º through 0º to 80º.	10º	
Torpedo Course:					
High Speed	10º	5'		20'	0º to 10º.
Low Speed	360º	10º		10º	0º to 360º.

APPENDIX

PRINCIPAL DRAWINGS

Director

Torpedo Director Mk 27 Mods 1 to 6-General Arrangement	Dwg 168000
Torpedo Director Mk 27 Mods 7 to 9-General Arrangement	Sk 118222
Torpedo Director Mk 27 Mod 2-Wiring Diagram	Dwg 199112
Torpedo Director Mk 27 Mods 1,3,4,5,6,7,8,9-Wiring Diagram.	Dwg 168050
Torpedo Director Mk 27 Mod 1-List of Drawings	Sk 57886
Torpedo Director Mk 27 Mod 2-Listof Drawings	Sk 58055
Torpedo Director Mk 27 Mod 3-List of Drawings	Sk 58363
Torpedo Director Mk 27 Mod 4-List of Drawings	Sk 92780
Torpedo Director Mk 27 Mod 5-List of Drawings	Sk 92716
Torpedo Director Mk 27 Mod 6-List of Drawings	Sk 132009
Torpedo Director Mk 27 Mod 7-List of Drawings	Sk 165883
Torpedo Director Mk 27 Mod 8-List of Drawings	Sk 165884
Torpedo Director Mk 27 Mod 9-List of Drawings	Sk 165885
Torpedo Director Mk 27 and Mods-Lubrication Chart	Dwg 253179
Spare Parts for Torpedo Director Mk 27 Mods 3, 4 and 5-BuOrd Allowance List	Sk 14632

Indicator

Torpedo Course Indicator Mk 1 and Mk 1 Mods 1, 2, 3, 4-General Arrangement-Plan View and Side Elevation	Dwg 160930
Torpedo Course Indicator Mk 1-Wiring Diagram	Dwg 160933
Torpedo Course Indicator Mk 1 Mod 1-Wiring Diagram	Dwg 180609

Torpedo Course Indicator Mk 1 Mod 2-Wiring Diagram	Dwgs 180685 and 230446
Torpedo Course Indicator Mk 1 Mod 3-Wiring Diagram	Dwg 238028
Torpedo Course Indicator Mk 1-List of Drawings	Sk 56912
Torpedo Course Indicator Mk 1 Mod 1-List of Drawings	Sk 58905
Torpedo Course Indicator Mk 1 Mod 2-List of Drawings	Sk 58649
Torpedo Course Indicator Mk 1 Mod 3-List of Drawings	Sk 92770
Torpedo Course Indicator Mk 1 Mod 4-List of Drawings	Sk 92783-5

Telescope

Telescope Mk 50-Outline Drawing	Dwg 163899
Telescope Mk 50 Mod 1-Outline Drawing	Dwg 181205
Telescope Mk 50-List of Drawings	Sk 56928
Telescope Mk 50 Mod 1-List of Drawings	Sk 59505

Firing Key

Firing Key Mk 19 (Combined Firing Key and Buzzer Contact Maker) General Arrangement	Dwg 153731
Firing Key Mk 19-List, of Drawings	Sk 56711

ELEMENT NUMBERS

Transmitter

1. Synchro generator, 1-speed, type 5G
2. Synchro generator, 36-speed, type 5G
3. Synchro generator, 2-speed, type 5G
4. Differential, DF-7, Otu
5. Differential, DF-8, Otu
6. Dial, 2-speed, Bto, Bgy
7. Dial, 4 1/2 speed, Otu
8. Dial, check, 36-speed
9. Hand crank, Otu
10. Hand crank, Bgy
11. Back Post, Bto2
12. Stop, Otu 13. Micrometer adjustment

Training Circle and Stop

14. Training circle and stop
15. Handwheel, Director Train

Computer

16. Angle-solver, front
17. Angle-solver, back
18. Follow-up motor, sight angle
19. Follow-up switch
20. Differential, DF-1, Bt
21. Differential, DF-2, Co
22. Differential, DF-3, Bto
23. Differential, DF-4, St
24. Differential, DF-5, Sto
25. Differential, DF-6, Xt
26. Differential, DF-9, Dsk
27. Stop, Osi
28. Stop, St
29. Stop, Sto
30. Dial, 1-speed, Bs, B, Dsk
31. Dial, 1-speed, B, Bt, Dsk
36. Hand crank, St
37. Hand crank, Ct
38. Hand crank, Sto
39. Hand crank, Osi
40. Hand crank, Kla
41. Hand crank, Co
42. Hand crank, Ds
43. Stop, Ds
44. Switch, contact arm, Os
45. Micrometer adjustment
46. Telescope Pivot
47. Scale, auxiliary sight angle
48. Telescope, Mk 50 Mod 0
49. Firing key, Mk 19 Mod 0
50. Dial, 1-speed-zero reader
51. Dial, 36-speed-zero reader

Own Ship Course

52. Synchro motor, type 5B
53. Servo motor, 115-volt AC
54. Heart-shaped follow-up switch
55. Dial, zero reader, Co
56. Dial, 1-speed, indicating, Co

Bearing Receiver

57. Synchro motor, 1-speed, type 1F
58. Synchro motor, 36-speed, type 1F
59. Dial, 1-speed, Bs
60. Dial, 36-speed, Bs

Torpedo Course Indicator

61. Synchro motor, 2-speed, Bgy
62. Synchro motor, 36-speed, Bto
63. Synchro motor, 1-speed, Bto
64. Dial, 2-speed, Bgy
65. Dial, 36-speed, Bto

32. Dial, 6-speed, KIa, Osi
33. Dial, 1 turn 60 knots, Sto
34. Dial, 1-speed, Ds, Dsk
35. Dial, 1 turn 60 knots, St
66. Dial, 1-speed, Bto
67. Dial, 1-speed, Btu
68. Differential

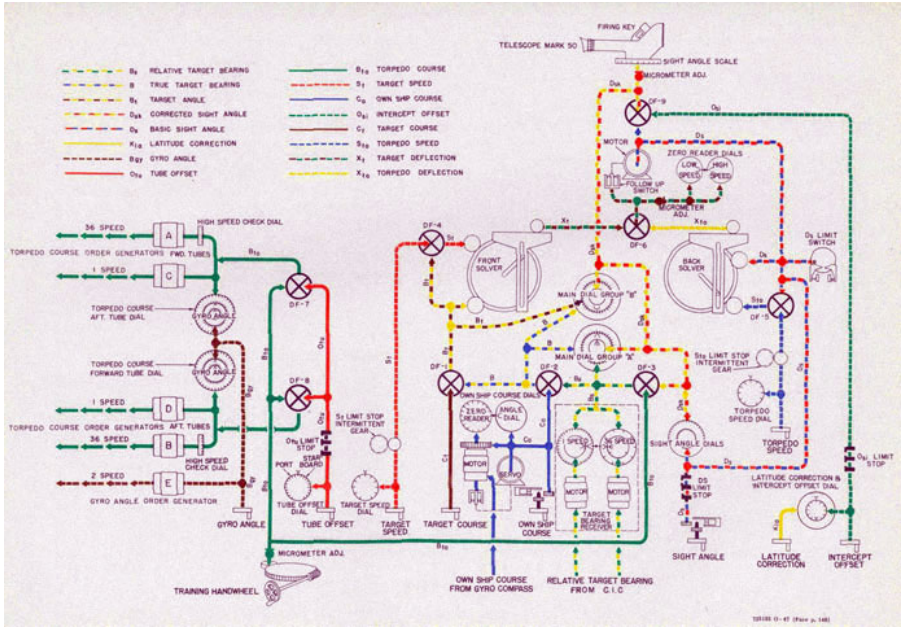

Figure 146-Functional diagram showing course of inputs and outputs through the Torpedo Director Mk 27 Mods 1,3,4,5,7,8 and 9.

OPERATION ROUTINE

This section will outline a suggested operation routine for putting the torpedo director into operating condition. This routine may vary somewhat with different ships depending upon ship's doctrine. In the following outline, the encircled numbers refer to the various hand cranks that are shown on figure 147.

1. After removing the tarpaulin cover, set in latitude correction, each morning, by turning the latitude correction knob (1). This can be done by the officer with the morning watch.

2. Turn on the power supply to the director and the torpedo control system at the fire control switchboard. Also, turn on the director heater supply.

3. Turn the bridge transfer switch to "PORT" or "STARBOARD".

4. Turn the director selector switch to "ON" and illumination switch to "TRANSFORMER".

The torpedo director is now ready to track a target. In setting up a problem on the torpedo

5. Match the intercept offset dial, with the reading on the latitude correction dial by turning hand crank (6). Set intercept offset as necessary to correct for torpedo turning circle when firing shots with large gyro angles.

6. Crank in torpedo speed by turning the torpedo speed hand crank (7).

7. Introduce gyro angle, as directed by the torpedo control officer, by turning the gyro angle crank (8).

8. Introduce target speed by turning the target speed hand crank (9).

9. Set target course into the director by turning the target course hand crank (10). Then train director on target using the telescope sight pr by matching the dials of the bearing receiver.

10. Fire the torpedoes, as directed, by closing the firing key (11).

The following procedure is suggested for securing the torpedo director:

director, the following procedure is suggested:

1. Train the director on the target by turning the training handwheel (2) to match the dials of the bearing receiver or to bring the telescope sight to bear on the target.

2. Set the sight angle crank (3) and the own ship course hand crank (4) to "OUT" position.

NOTE: In case of power failure, these hand cranks should be left in the "IN" position. As the problem progresses, the own ship course hand crank must be turned to keep the zero reader dial at "0", and the sight angle hand crank must be turned to keep the high- and low-speed reader dials matched at "0".

3. Introduce tube offset by turning the tube offset crank (5).

4. Introduce refined latitude correction by turning the knob (1) to correct for torpedo creep.

1. Train the torpedo director to its stowed position, relative bearing "0 ".

2. Set all the dials of the torpedo director to zero by turning the various hand cranks.

3. Turn the director selector switch and the illumination switch to "OFF".

4. Turn the bridge transfer switch and the heater switch to "OFF".

5. Turn off the power to the torpedo director at fire control switchboard.

6. Cover the torpedo director with tarpaulin provided.

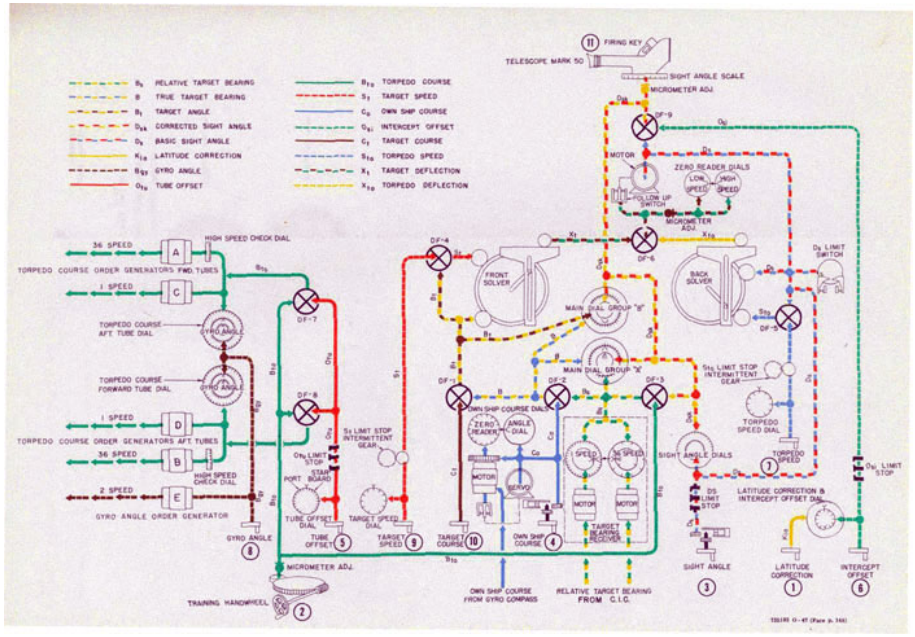

Figure 147-Diagram of suggested operation routine.

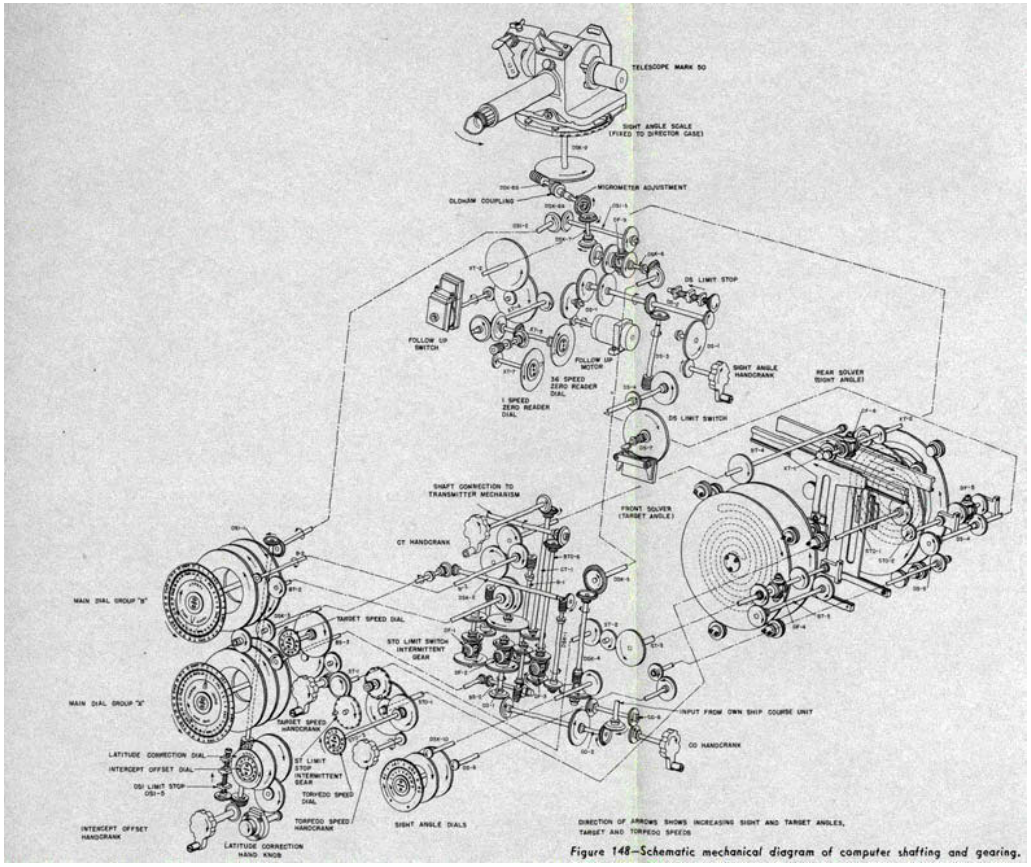

Figure 148-Schematic mechanical diagram of computer shafting and gearing.

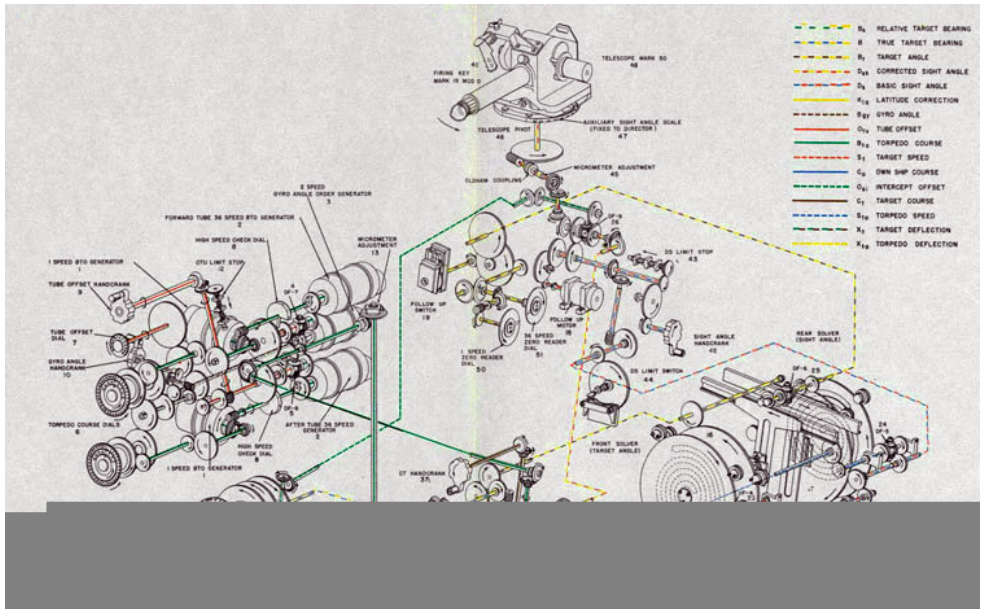

Figure 149-Mechanical diagram of Torpedo Director Mk 27 Mods 1, 3, 4, 5, 7, 8 and 9.

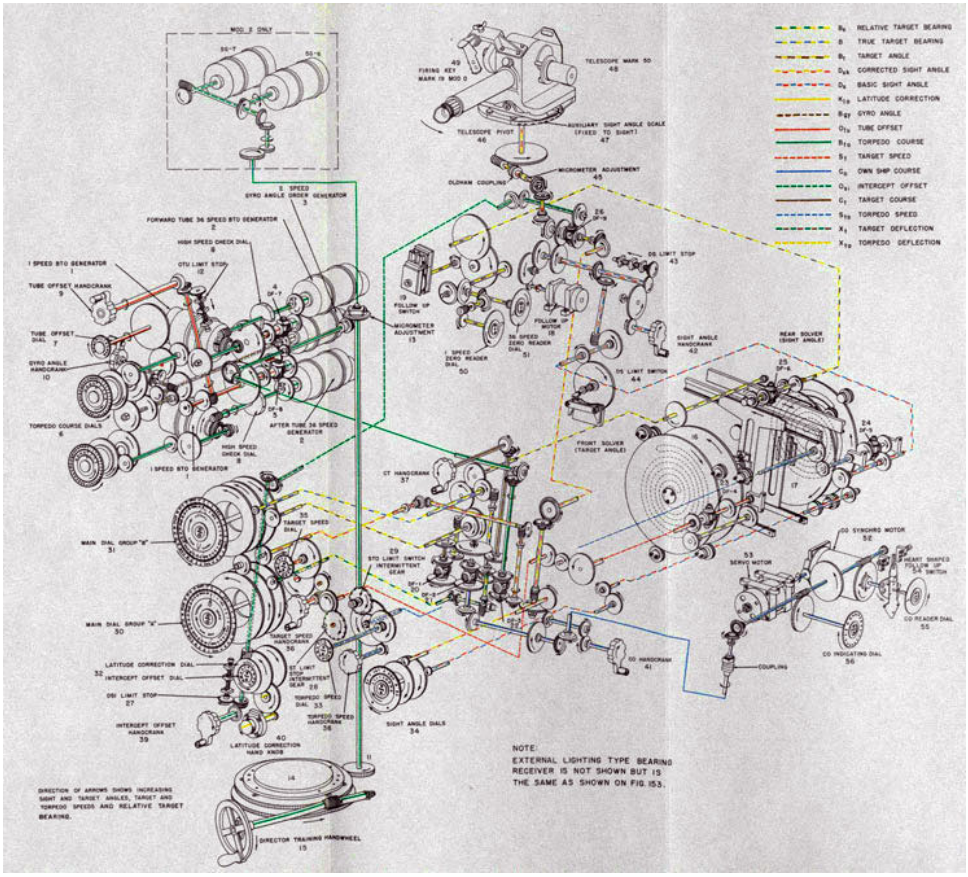

Figure 150-Mechanical diagram of Torpedo Director Mk 27 Mod 2.

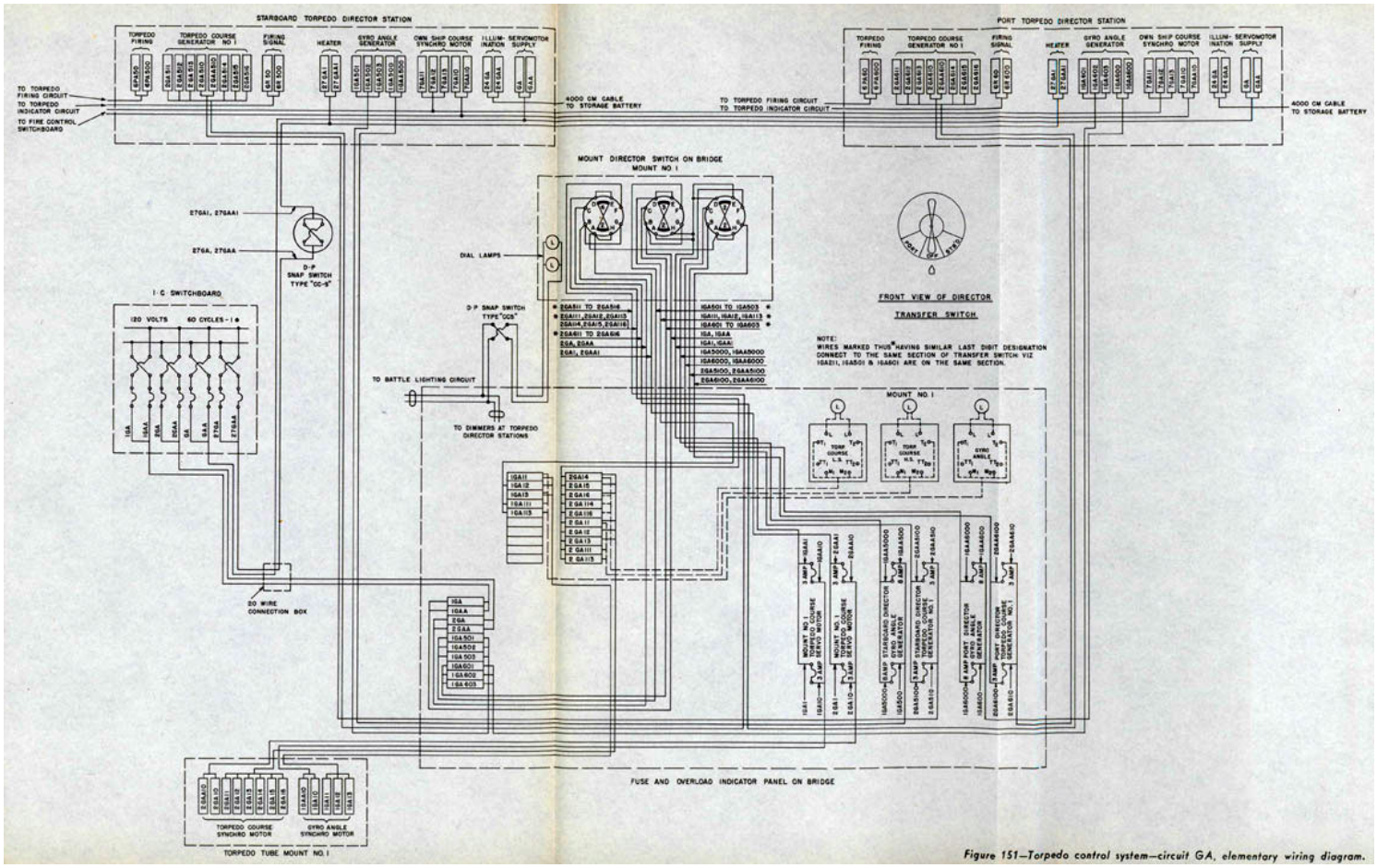

Figure 151-Torpedo control system-circuit GA, elementary wiring diagram.

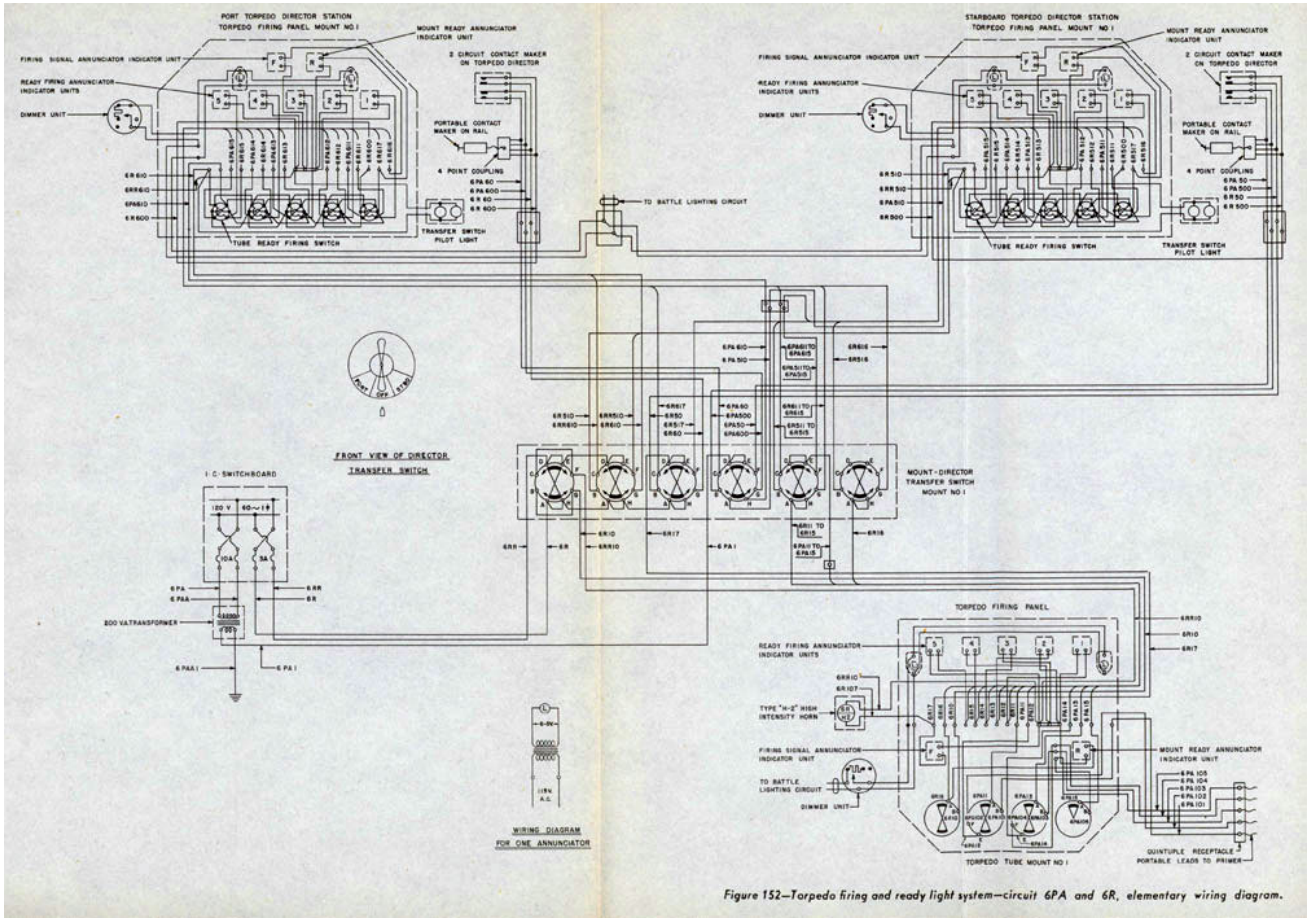

Figure 152-Torpedo firing and ready light system-circuit 6PA and 6R, elementary wiring diagram.

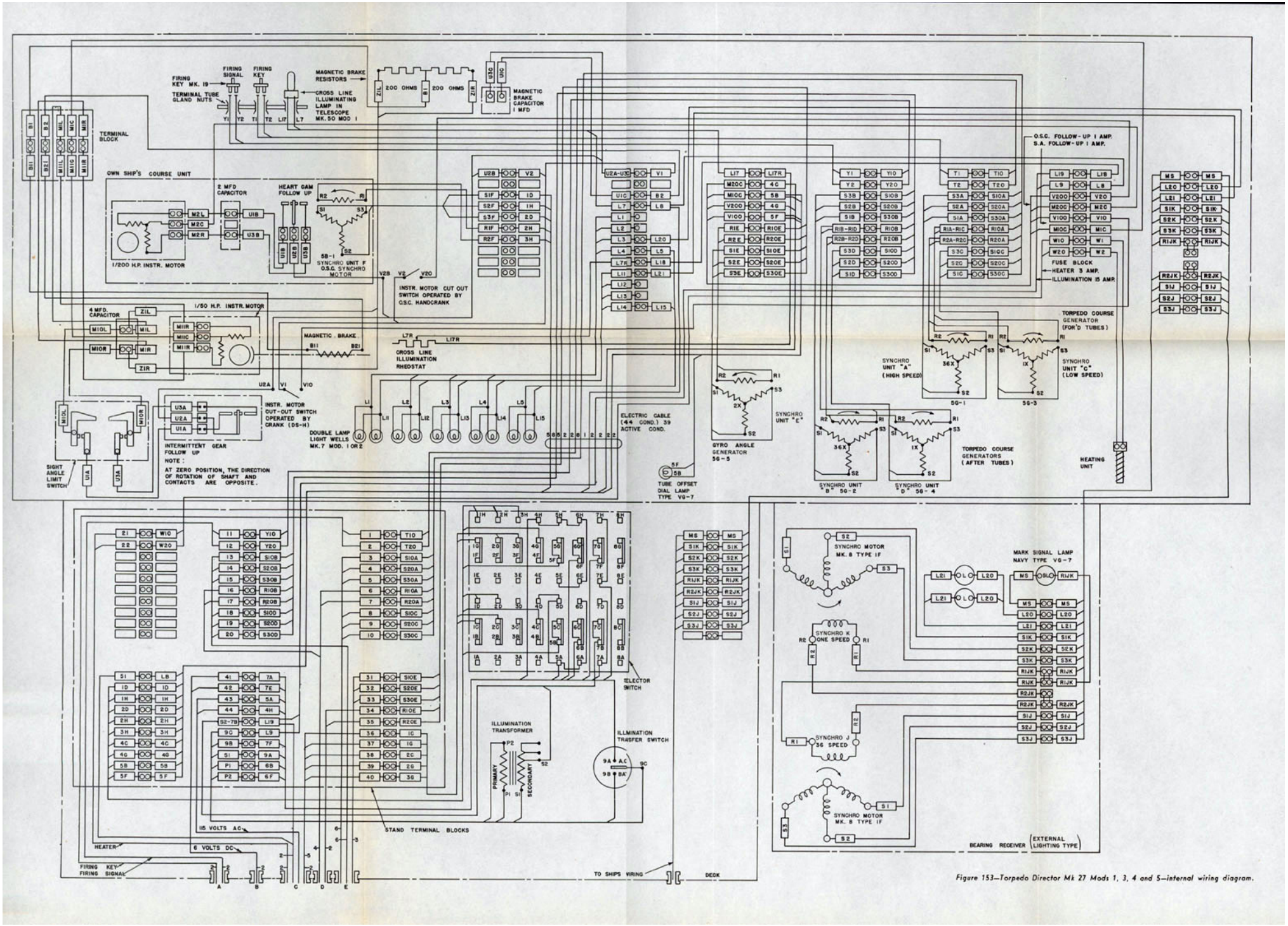

Figure 153-Torpedo Director Mk 27 Mods 1,2,3,4 and 5-internal wiring diagram.

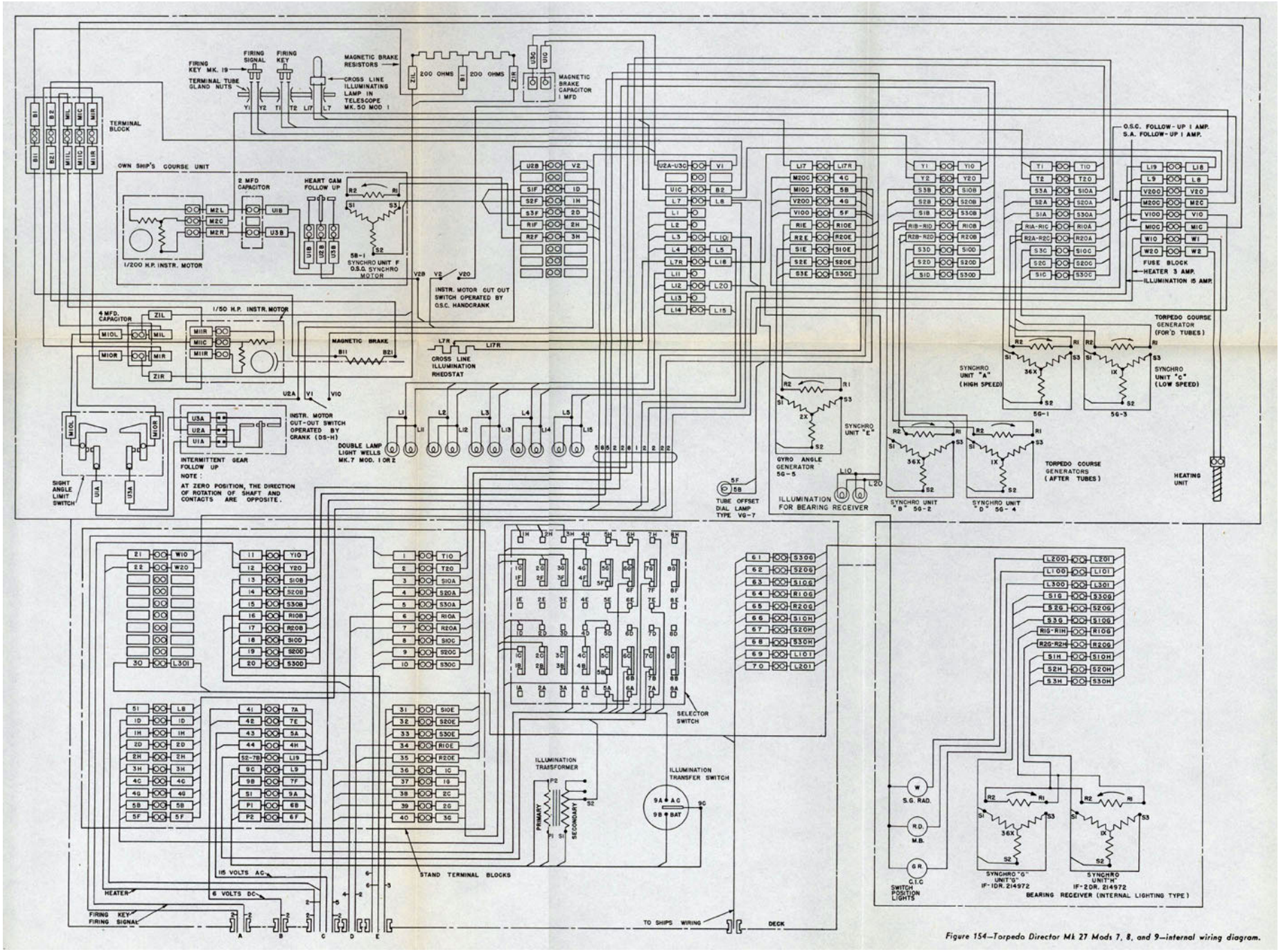

Figure 154-Torpedo Director Mk 27 Mods 7,8, and 9-internal wiring diagram.

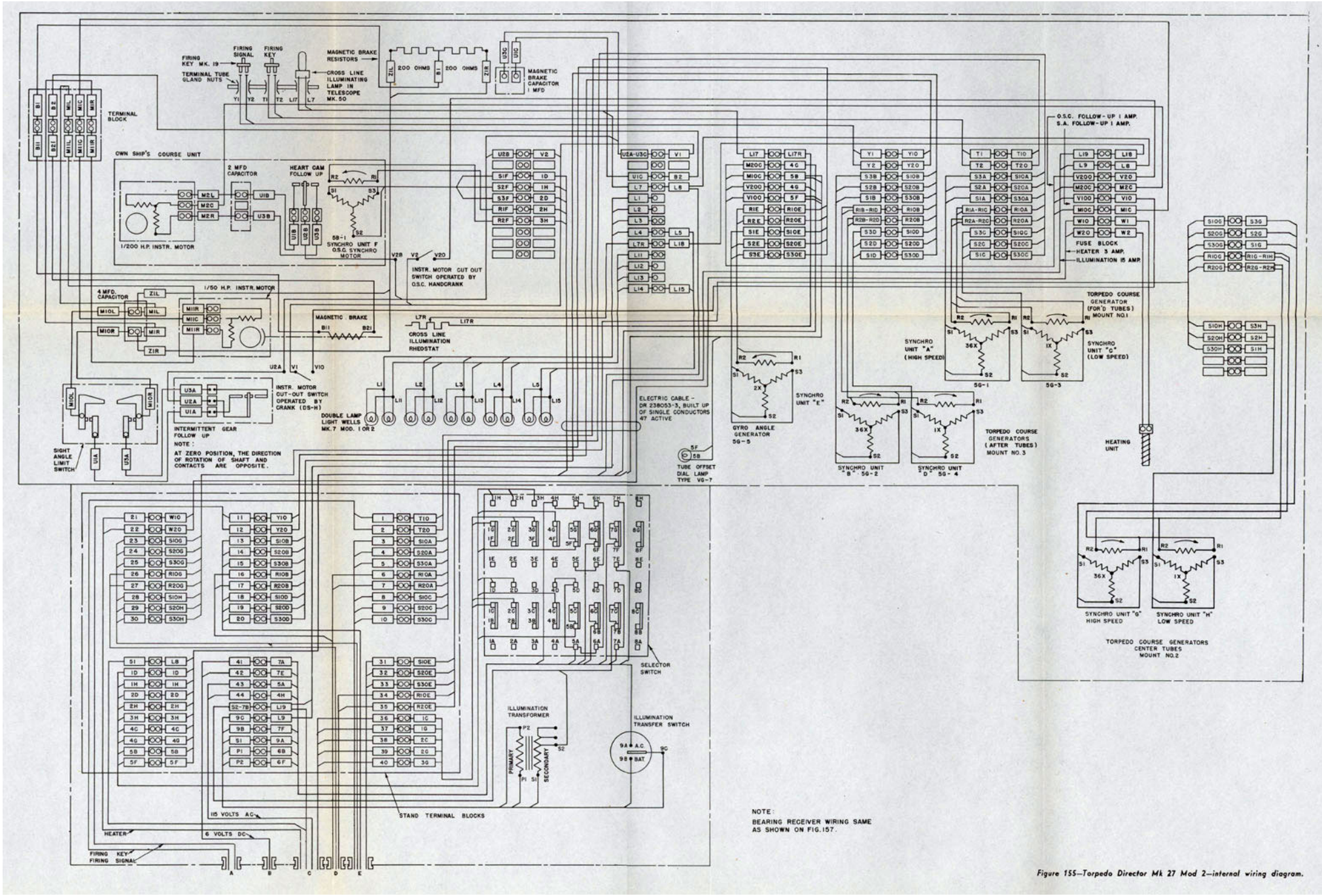

Figure 155-Torpedo Director Mk 27 Mod 2-interal wiring diagram.

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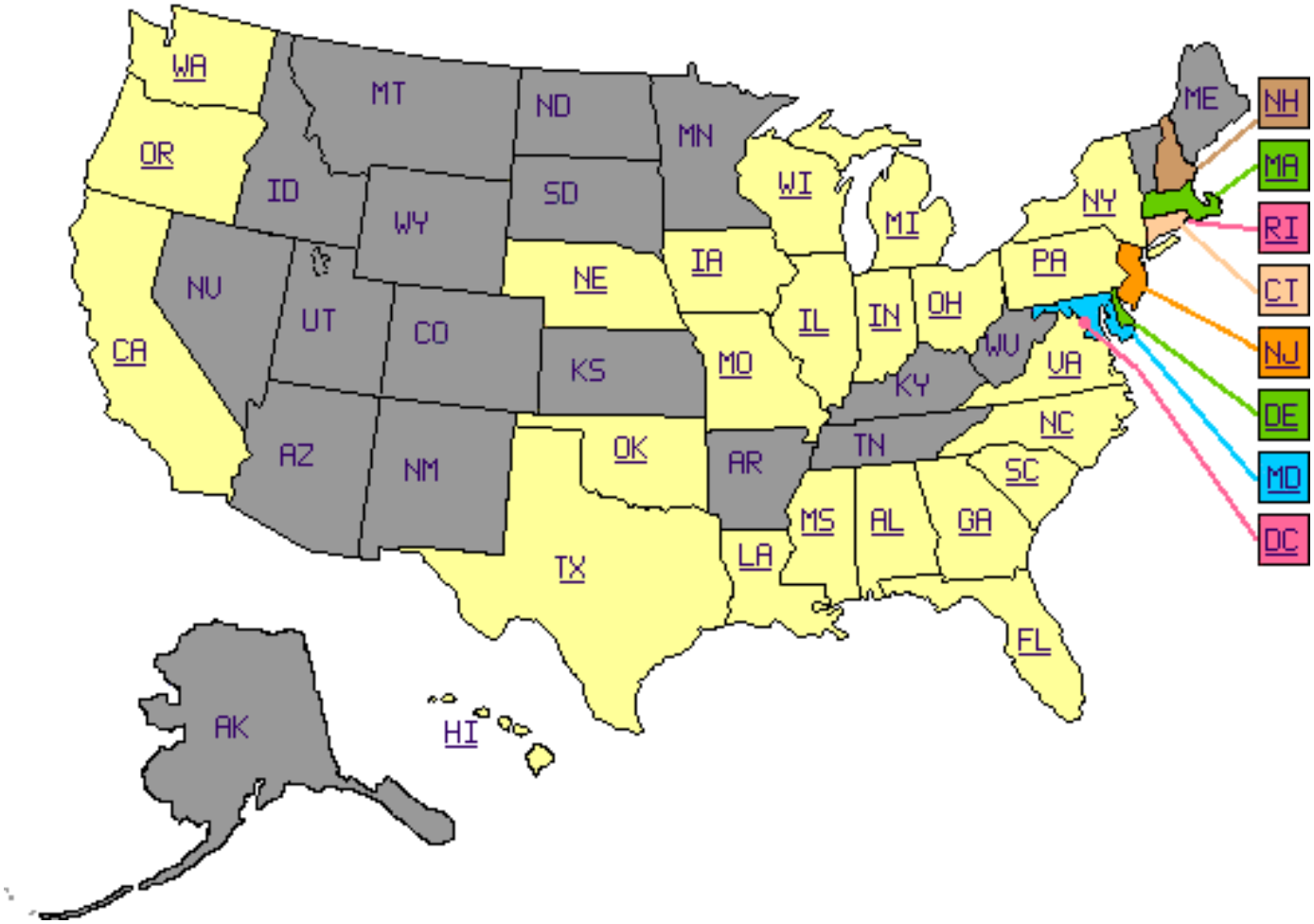

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